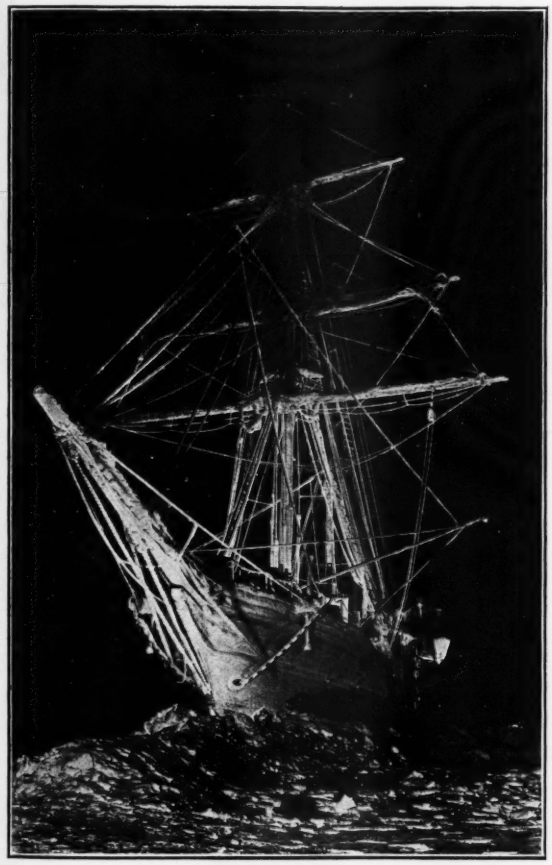
DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. IX. No. 101. MAY, 1928. PRICE 1s. NET



THE ENDURANCE.

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Trustees: Sir J. J. Thomson, O.M., F.R.S., Sir F. G. Kenyon, K.C.B., F.B.A., Professor A. C. Seward, Sc.D., F.R.S., Professor R. S. Conway, Litt.D., F.B.A.

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Editorial Notes.

In Palestine the archaeologist is peculiarly favoured by the contemporary accounts which are usually to be found in the Old Testament, and the site of Beisan is no exception. For centuries this ancient city was a key to the great highway from the Mediterranean to Transjordania, and remains of nine city-levels dating down to Arabic times have been found there by the American expedition. A special report is contributed this month by Mr. Alan Rowe, who has been Field Director since 1925, and was previously with the same expedition—as assistant—in 1922 and 1923. During the two years intervening he excavated in Egypt at Thebes, Girgeh, and the Gizeh Pyramids, also at Semneh in the Sudan. The latest layer unearthed at Beisan contains two Canaanite temples of 1500 B.C.; one of these was made for the god Mekal, whose name is here met with for the first time in archaeology. It seems quite certain that Mekal is a form of the god Resheph, the name undoubtedly referring to the great heat and general unhealthiness of Beisan in the summer time. Among the incidental finds are a number of clay objects, representing rolls of bread or cakes; these may throw light on the altar bread ceremonies recorded in the *Book of Samuel*, where the frequency of renewal is unspecified.

* * * * *

The advent of ethyl petrol in England has at once been greeted with storm of "warning" by various well-known chemists as well as by politicians, with the result that its use has been referred to a Government Committee for expert opinion. In view of the mass of evidence already collected in America, this step is difficult to justify, but at present we seem to be passing through a phase in which a committee is regarded as an almost divine dispensation for any problem or trouble. The critics of ethyl petrol appear to have confused the manufacture of tetraethyl lead with commercial ethyl spirit, which contains only one part in 1,300 of the former dangerous substance—a proportion proved not to cause the slightest danger when used as motor fuel. Last year over 500,000,000 gallons of ethyl petrol were sold in America. Official investigations there have not so far found a single case of ill-effects from its use, though certain precautions in handling are advised. The new spirit is claimed as a wonderful discovery, adding remarkable properties to ordinary petrol, and prejudice against it is unjustified on present evidence.

* * * * *

After many disastrous attempts to fly the Atlantic from east to west, success was achieved on 13th April. The German aviators, Herr Köhl and Baron von Hünefeld, were accompanied by Commander Fitzmaurice, of the Irish Air Force. Of all the attempts so far made, this was probably most deserving of success: we do not detract from the courage of previous flights in regarding them mainly as adventurous exploits. The victors, however, had approached the task in a scientific spirit from the moment when they turned back last year on their first attempt, the weather proving unfavourable. The machine was a Junkers monoplane. By a happy coincidence the French flight round the world ended on the following day, 14th April. Captain Costes and M. Le Brix left Paris for Buenos Aires last October, and had made the southern Atlantic crossing in stages.

* * * * *

At the time of writing, troubles are impending again in China, but it is always difficult to obtain from the press an adequate idea of their significance. An illuminating detail has just reached us from an American correspondent, in an appeal for funds for the Princeton University Mission in Peking. Of late this work has been concentrated in the teaching of

sociology at Peking University, where the best of Western culture is given to a select group of Chinese students; the main purpose of the mission being "to train young men and women of China for the modernization of their country." The reader begins to picture the oriental eyes already opening wider behind horn-rimmed spectacles, rapidly becoming imbued with efficiency, when he reads on as follows, in connexion with recent expenditure: "To prevent any disturbance by marauding war lords, a great wall has been built round the grounds of the university by its many devoted supporters. As a result the university has not been closed a single day during the recent civil strife." We looked at the letter again, but it was not written in the Middle Ages—the postmark was Chicago, March, 1928.

* * * * *

On another page this month, dealing with the new star in Pictor which has just caused a sensation by becoming double, Dr. Crommelin remarks on the spasmodic character of popular interest in astronomy. While astronomers are pleased at seeing such a large amount of attraction in this occurrence, they would be still more glad if the interest were a permanent one. There are countless marvels continually present in the heavens, but these attract little public interest; whereas anything of a bizarre nature, such as the Pictor occurrence, relating to a pair of faint telescopic orbs far out of reach of European observers, produces flaring headlines in newspaper placards, and occupies many columns of text. We may, at least, assure Dr. Crommelin that his own efforts are not wasted on the many who enjoy his notes every month in *Discovery*.

* * * * *

Conditions in Europe have been changing so rapidly since the war that to follow them intelligently has for most people been frankly impossible. The greatest interest therefore attaches to a series of lectures recently delivered at the City of Birmingham Commercial College, and now collected in a volume* edited by the principal, Mr. Henderson Pringle. As no limitations were imposed, the lecturers naturally approach their subjects from differing angles; the Hon. George Peel, for example, discusses France on the general basis of statistics, in particular regarding the monetary crises through which she has passed since the war. The choice of the writer on Italy was, however, an unfortunate one for a series of impassionate studies: Professor Salvemini could hardly be expected to take any but a partisan view of the Fascist regime from which he is in exile. Of quite other character is Mr. Michael Farbman's essay on Russia, to which one naturally turns with great curiosity. While frankly criticizing the new conditions where criticism is called for, he approaches the subject with sympathy and an obvious insight into the psychology of the Russian people. The knowledge of the Revolution that has accumulated during the last ten years enables us quite safely to declare that not only the upheaval of February, 1917, which overthrew the Monarchy, but all the subsequent stages were clearly connected with the Agrarian Revolution of 1905, and, in fact, derived their driving force from it. For the future, as between socialism and capitalism, Mr. Farbman states that "it cannot be doubted for a moment" that the tendency of Russia is towards capitalism. The peasant has at last become a conscious factor in Russian history and has now, as it were, turned his face to Europe. "The future of Europe," we are told, "may depend on whether this present occidental tendency meets with welcome or repulse."

* * * * *

A curious problem about a bird which flew through a plate-glass window without damaging itself is advanced by Sir Herbert Maxwell in a letter to *The Times*. On entering the room his first thought was that a football had been kicked through the pane, so round was the hole; but soon a hen-pheasant was discovered crouching by the fireplace. "We are told," says Sir Herbert, "to regard force as no more than the rate per unit of length at which energy is transferred or transformed; but this does not carry the ordinary citizen far towards understanding how a hen pheasant's beak can be driven uninjured through plate-glass, or how the slender cannon-bone of a horse may suffer no abrasion in smashing an oaken rail; whereas if the same oaken rail were driven against the leg of a stationary horse there can be no doubt which would be shattered. It is said that a man may drive his fist through the panel of a door if he aims resolutely at a point a foot behind the panel—the experiment is not likely to become popular; but the horse, in striking and breaking the rail, is aiming at landing in the field beyond. So the hen pheasant, deceived by the reflection of a woodland glade in my library window, was unconsciously directing her flight at something on the far side of the glass." Everyone who lives in the country has seen a small bird fly against a window, often repeatedly as if it failed to see the glass. The beak might readily pierce the glass undamaged, but how a hole occurred of sufficient size to admit the body remains a mystery.

*"Economic Problems in Europe To-day" (Black, 5/-).

The New Discoveries at Beisan.

By Alan Rowe.

Field Director, Palestine Expedition, University of Pennsylvania Museum.

In a specially-contributed article, Mr. Rowe deals with the American excavations at Beisan. Two Canaanite Temples of Thothmes III, dating back to 1500 B.C., are new discoveries on this remarkable site.

EVER since 1921 the Palestine expedition of the Museum of the University of Pennsylvania has been engaged in excavating the site of the ancient city of Beth-Shan, at present called Beisan, which lies in north Palestine at the eastern end of the valley of Jezreel. This city, which since time immemorial had been the key to the Jordan end of the great highway extending along the valleys of Esdraelon and Jezreel, from the Mediterranean Sea to the country now known as Transjordania, is to-day represented by a small town resting on the southern side of the River Jalud, a swiftly flowing stream which runs eastward into the River Jordan. Between the town and the River Jalud is Tell el-Hosn, or "Mound of the Fortress," which chiefly consists of the remains of super-imposed citadels ranging in date from the earliest age to Arabic times. On the north side of the mound, and on the other side of the river from the tell, is an extensive cemetery—one of the largest in Palestine—which has been proved to contain burials of all periods, from the Early Bronze Age to the Byzantine Era.

Up to the present nine super-imposed citadels, or city-levels, have been found on the tell, particulars of which are given in the list below.* (It should be noted that during the time from 1374 B.C. to 1314 B.C., the temple of Amenophis III was still in existence, so that No. VII level may really be said to have come to an end at the latter date.)

In this article we are only concerned with the two temples belonging to the time of Thothmes III, which were found during the 1927 autumn season; these temples are essentially Canaanite in origin, and had no connexion whatever with Egyptian archetypes. They were all made of brick, and had their walls covered with plaster.

Southern Temple of Thothmes III.

The great southern temple of Thothmes III is about 138 feet in length from south to north, and its excavated width is more than eighty feet. The axis of the temple lies from south to north. The temple consists of:—

(1) *An Inner Sanctuary.* This has a central brick altar, twenty-two inches in height, with a flight of three steps leading up to it. On a small wall to the right of the steps is a shallow stone basin which held the blood offerings for the deity. This altar was chiefly used as a table for the various sacred objects, jewellery, beads, etc., which were found lying on the ground around it. The sacred objects consist of a beautifully decorated chalice of pottery; a two-handled cylindrical cult object for holding the flowers, fruit, etc., which were placed in it during the festivals connected with the renewal of vegetation; a well-made pottery figurine of the goddess Ashtoreth; an ivory cosmetic pot on a stand; two gold pins of Cypriote type; a panelled Cretan altar with a cross in high relief on its top (the cross was a general indication of "divinity"); a gold-covered figurine of a god; a magnificent amethyst scarab of Sesostris I, a king of the XIIth Dynasty, 1970-1935 B.C.; a steatite mould for articles of jewellery; many scarabs and scaraboids; and a Hittite dagger with a curved end. This dagger is very much like a dagger worn by a king represented on a gateway in the Hittite capital of Boghaz-keui in

*City-Level	Historical Periods represented by each Level.	Dates.
IX.	Thothmes III. (*Two Canaanite Temples*—southern one made for "Mekal, the god of Beth-Shan")	1501 B.C.—1447 B.C.
VIII.	Pre-Amenophis III	1446 B.C.—1412 B.C.
VII.	Amenophis III. (*Canaanite Temple.*) Length of reign	1411 B.C.—1375 B.C.
VI.	Seti I. Two levels—Late Seti; Early Seti. (*Canaanite Temple*)	1313 B.C.—1292 B.C.
V.	Rameses II. (*Two Canaanite Temples*—northern one, "House of Ashtaroth" of 1 *Sam.* xxxi, 10, and southern one, "Temple of Dagon" of 1 *Chron.* x, 10. Both were in use until at least Israelitish times, *i.e.*, c. 1000 B.C.)	1292 B.C.—1225 B.C.
IV.	Late Ramesside, Philistine, Israelite, Assyrian, Scythian, New Babylonian, Old Persian, etc.	1224 B.C.— 302 B.C.
III.	Hellenistic. (*Temple.*) Jewish and Roman	301 B.C.— A.D. 329
II.	Byzantine, or Eastern Roman Christian. (*Circular Church*)	A.D. 330— A.D. 636
I.	Arabic. (*Mosque*). Crusader, etc....	A.D. 636—19th century (approx.).

Anatolia; and in this connexion it is interesting to mention the fact that the axe which the king holds is very similar in type to an axe found in the Canaanite temple of Amenophis III at Beisan during 1926.

In front and just to the south of the brick altar is another altar, some twelve inches in height, which is made out of two pieces of stone, one circular in shape and one rectangular. The former stone is placed against the eastern end of the latter. Upon this stone altar were probably laid the cooked meat sacrifices which were offered up to the deity. As a matter of fact, we actually found the shoulder-blade of a young bull near the altar. This shoulder-blade is most important, as it forms part of an animal-sacrifice made in the temple, to which we shall refer later on. The sanctuary of the southern temple of Thothmes III is but an earlier type of the sanctuaries of Amenophis III and Seti I in the upper levels. The later sanctuaries, however, had the northern altar erected in a room raised above the level of the room in which the southern altar was placed. The two temples of the time of Rameses II at Beisan were evolved from a different type of building altogether.

(2) *Room with Altar of Sacrifice.* Immediately to the south of the inner sanctuary, from which it is divided by a thick wall, is a room containing a great altar of sacrifice. This altar is built up against the west end of the above-mentioned wall, and has two steps leading up to it from the entrance passage of the sanctuary. On top of the lower step is a rectangular slab of basalt, which perhaps was originally part of the altar itself. The altar is of brick, and is about twelve inches in height. In the top of it is an L-shaped channel, eight inches in width, and eight inches in depth, in which the blood from the sacrificed animal was carried away to an outlet at the east of the altar. In the southern side of the longer part of the channel is a hole for a wooden peg for tethering the animal to be sacrificed. Just against the south side of the altar were lying the two horns of a bull that

THE NEWLY-DISCOVERED TEMPLES OF THOTHMES III AT BEISAN.

On the back wall of the large cutting made in the mound various city-levels are indicated. This view is taken looking north-east, and shows a section of the southern temple, together with the partially excavated northern temple. Notice also the inner sanctuary.

VIEW OF BEISAN VILLAGE AND PART OF THE EXCAVATED AREA.

This southern section of the Temple of Mekal, looking south-east, includes the *mazzebah* or sacred column. The inner sanctuary on the left connects with the same feature in the view opposite. In the distance is the Jordan valley, with the mountains of Gilead.

had been sacrificed upon the altar. A collar bone of a bull, together with a sacrificial dagger of bronze, were found in the courtyard (which is outside the sanctuary) just to the west of the altar steps. Doubtless this collar bone and the horns, as well as the shoulder-blade found in the inner sanctuary, belonged to one and the same animal, which was probably the last to have been sacrificed in the temple. The bull, as shown by the skeletal remains, was about three years old, and in this respect, one is reminded of the bullock of three years old that was offered up by Hannah in the " house of the Lord " in Shiloh.*

Near the place in the courtyard where the dagger and the shoulder-blade were discovered, is a socket for the pole upon which the carcase of the bull was dressed after the animal had been sacrificed upon the altar close by. In some of the Egyptian funerary papyri, as, for instance, the Papyrus of Anhai in the British Museum, we see the carcase of a bull suspended from a pole inside a shrine containing the god Ptah-Seker-Osiris. Here the head of the bull hangs downwards and blood pours from the neck of the animal into a pot at the base of the pole. Near the pole in the courtyard of the southern temple was lying a heavy bronze pendant, about five inches in height and four and a half inches in breadth. On one side of the pendant is depicted a lion seizing a bull by the neck. This pendant was undoubtedly suspended from the neck of the bull before it was sacrificed. Some of the details of the temple are not unlike some of the details of the ideal temple described by the Prophet Ezekiel (VIth century B.C.), cf. *Ezekiel*, xl. The latter building had its altars of sacrifice outside the inner sanctuary, and also an altar inside the sanctuary.

(3) *Southern Corridor and Sacred Column.* On the south side of the temple is a long corridor leading to the east into a small room containing a *mazzebah*, or " sacred column," emblematic of the god of the temple. The *mazzebah* consists of a roughly-hewn cone-shaped piece of basalt set upon foundation stones of the same

*See 1 *Samuel*, i, 24, 25, R.V., margin.

material. Just to the south of the column is a basalt libation cup sunk in the floor; this was for the purpose of catching the blood offerings that drained off the column. The floor around the column and the cup is made of bricks. The southern corridor and the *mazzebah*-room were doubtless the only parts of the temple in which the laity were allowed; the inner sanctuary was, of course, strictly reserved for the priests. There are four small stone bases near the *mazzebah*, three of which doubtless held sacred objects.

The God Mekal.

The other stone seems to have been a base for an Egyptian stele which we found in the debris a little to the west of the room. This stele is of great importance, as it gives us the actual name and epithet of the local god who was worshipped in the temple itself, that is to say, "Mekal (or Mekar), the god of Beth-Shan." From the inscriptions we learn that the monument was made for a builder named Amen-em-Apt by his son Pa-Ra-em-Heb. Mekal is represented as seated on a throne holding the *was*-sceptre of "happiness" in his left hand, and the *ankh*-symbol of "life" in his right hand. He wears a conical helmet with two horns fixed to the front of it. Attached to the back of the helmet are two streamers, one at its top, and one at its base. The god is bearded and wears an ornamented collar. It seems quite certain that Mekal (whose name is here met with for the first time in the history of archaeology) is a form of the god Resheph, who is sometimes represented like Mekal. "Resheph" means "fiery shafts," "burning heat," "pestilence," etc. "Mekal" is probably connected with the verb *akal* (*aleph-k-l*)—see, for instance, II *Kings*, i, 14—meaning "to devour." If this is so, the attributes of Resheph the god of heat and pestilence are practically the same as those of Mekal, "The Fierce Devourer," whose name undoubtedly refers to the great heat and general unhealthiness of Beisan in the summer time. On the other hand, it might be that the word *Mekal* is an intentional transposition of the word *Melak* or *Malek* (=Molech—see *Jeremiah*, xxxii, 35), "king," the god of devouring fire and pestilence. A figure of a god dressed like Resheph was found in the southern temple of Rameses II at Beisan. In Phoenician inscriptions of the fourth century B.C. found in Cyprus, are references to a god called Mekel or Reshep-Mekel, the latter being translated into Greek as "Apollo Amyclaeus." It may well be Mekel is a later form of the older deity Mekal worshipped at Beisan. The association of the former god with Reshep (Resheph) is interesting.

Over a hundred cigar-shaped objects of mud, each three and a half inches in length, were unearthed in the southern corridor of the temple. These are evidently votive offerings, and doubtless represent small rolls of bread or cakes. Compare *Jeremiah*, vii, 17, 18: "Seest thou not what they do in the cities of Judah and in the streets of Jerusalem? The children gather wood, and the fathers kindle the fire, and the women knead their dough, to make cakes to the queen of heaven (*i.e.*, Ashtoreth), and to pour out drink offerings unto other gods."*

(4) *Courtyard West of Inner Sanctuary.* This courtyard contains two rectangular table-like structures of brick, with a small square pedestal of brick between them. Upon these tables were doubtless placed those portions of the sacrificed bull which were not offered up to the deity in the inner sanctuary. Probably these portions were eaten outside the temple, or in its southern corridor, by the laity, and the portions for the deity were eaten in the sanctuary by the priests (cf. I *Samuel*, ii, 14, 15, and I *Samuel*, i, 18, in the LXX, also Driver, *Books of Samuel*, p. 15). The small pedestal between the tables may have held the implements with which the flesh was divided, cf. *Ezekiel*, xl, 42.

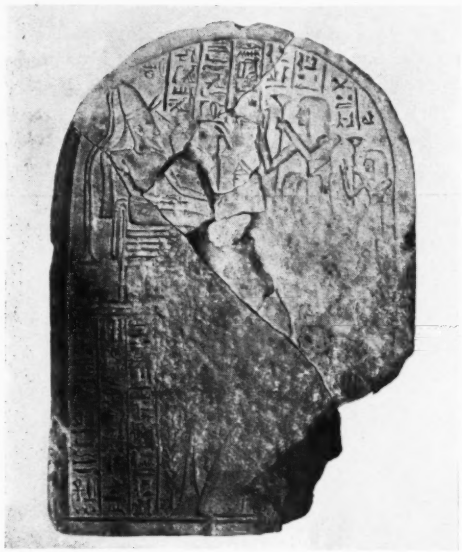
(5) *Room North of Sanctuary.* There is a large room to the north of the sanctuary. Upon its walls and also on those of other rooms are pedestals of brick, which were probably used for the purpose of supporting the posts holding the boards with which the temple seems to have been screened.

As will have been seen from the above description, the great southern temple of Thothmes III at Beisan is one of the most remarkable sacred buildings of its kind ever found in Palestine.

Northern Temple of Thothmes III.

The building, which we have provisionally called the northern temple of Thothmes III, is about eighteen feet to the north of the great temple of the god Mekal, and is not yet entirely cleared. From what can be seen the temple is rectangular in shape, with a dividing wall running across it from south to north. On its eastern wall are four brick pedestals. On the north side of the temple is a flight of five steps leading to a lower level. The temple

* A votive cake of clay found in the Seti I level at Beisan had a seal bearing the Egyptian words "daily offering" impressed upon it fourteen times, which indicates that the cake was an offering for providing a daily supply of bread for the deity. The daily preparation of the bread in the Seti I instance may well throw considerable light on the periodicity of renewing the bread as recorded in I *Samuel*, xxi, 6, where the frequency of renewal is left entirely undetermined. Compare the *later* seventh-day renewal in *Leviticus*, xxiv, 7, 8.



STELE OF THE GOD MEKAL.

This inscribed column shows the Egyptian representation of the local Baal, and is of great importance as giving the actual name of the god. The Canaanite representation consisted of the *Mazzebah*.

was apparently dedicated to the female counterpart of Mekal. The two temples in this level form an analogy to the two temples in the Rameses II level, one of which was dedicated to a god (Resheph) and the other, the smaller of the two, to a goddess (Antit).

Just outside the northern temple we found a bowl with an undulating serpent represented on its side. This object is of great importance, as it indicates that ophiolatry, so prevalent in the town during the reigns of Amenophis III, Seti I and Rameses II, was already practised there in the time of Thothmes III. In view of the fact that the excavations have shown that Beisan was the centre of a great serpent-cult in Palestine, one wonders whether its ancient name, "Beth-Shan," or "House of Shan," reflects a far distant connexion with the old Sumerian serpent-deity whose Semitic name was "Shahan" or "Sakhan." The Museum of the University of Pennsylvania actually possesses a cylinder seal showing the figure of Shakhan.

We shall, of course, never know the exact details of the worship carried out in the Canaanite temples at Beisan, but we can form some idea of its nature by an examination of the various cult objects, altars, and other remains found in the sacred buildings. If an ancient Hebrew could have visited the temples he would doubtless have observed, like the author of *The Epistle of Jeremy* (beginning of IVth century B.C).—who has left us the following account* of what he apparently saw in the temples of Babylon—the

"Gods of silver, and of gold, and of wood, . . . which cause the nations to fear. . . . Their tongue is polished by the workman, and they themselves are overlaid with gold and silver; yet they are but false, and cannot speak. . . . Having no feet, they are borne upon shoulders, whereby they declare unto men that they be nothing worth. They also that serve them are ashamed: for if they fall to the ground at any time, they cannot rise up again of themselves: neither, if one set them aright, can they move of themselves: neither, if they be set awry, can they make themselves straight: but the offerings are set before them, as if they were dead men. . . . For how can they be called gods? because women set meat before the gods of silver, gold, and wood. And in their temples the priests sit on seats, having their clothes rent, and their heads and beards shaven, and nothing upon their heads. They roar and cry before their gods, as men do at the feast when one is dead. . . . And ye shall know them to be no gods by the bright purple that rotteth upon them: and they themselves afterward shall be consumed, and shall be a reproach in the country. Better, therefore, is the just man that hath none idols: for he shall be far from reproach."

And now over the great mound of Beisan, where the roaring and crying of the temple priests no longer resounds, there daily floats across the still air from the village mosque the call to prayer:

"God is the greatest. God is the greatest. God is the greatest. God is the greatest. I testify that there is no god but God. I testify that there is no god but God. I testify that Mohammed is the Apostle of God. I testify that Mohammed is the Apostle of God. Come to prayer. Come to prayer. Come to success. Come to success. God is the greatest. God is the greatest. There is no god but God."

For the worship of the "Fierce Devourer" and the "Queen of Heaven" has long passed away, and that of the God of Islam and of Israel reigns supreme.

THE MAZZEBAH OR SACRED COLUMN.

The position which this column occupied in the temple may be seen in the view on page 139. It consists of a cone-shaped piece of basalt set on foundations.

* Charles, *Apocrypha, etc., of the Old Testament*, i, pp. 600-611.

The New Star in Pictor Becomes a Double Star.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

Some weeks ago the surprising announcement was made that a star had split into two. "Nova Pictoris" is not visible in our hemisphere, and various theories—fantastic and otherwise—have been advanced to explain this occurrence. Dr. Crommelin here recounts the discovery and history of the star, and its latest behaviour.

On 25th May, 1925, a new star was detected by Mr. Watson at Beaufort West, South Africa, some 10° south of the brilliant Canopus, and therefore quite out of reach of European observers; it was the fourth bright Nova of the century; the others were Nova Persei in 1901, Nova Aquilae in 1918, Nova Cygni in 1920. The star of 1925, known as Nova Pictoris, resembled the others in having been previously present as a faint star (in this case of magnitude 13), as was found on the examination of photographs taken before the outburst; but it differed from them in its more leisurely ascent to maximum; it is reported in *Harvard Bulletin* No. 823 that the star had already attained the third magnitude six weeks before its detection. It did not, however, reach its maximum light till fifteen days after its detection; moreover, there was a second, slightly higher, maximum some weeks later, and the decline was also leisurely, so that the star was still plainly visible to the naked eye at the end of 1925 (magnitude $4\frac{1}{2}$).

An Immeasurable Distance.

Nova Pictoris was at a greater distance from the Milky Way than most new stars, the distance being 24°; however, Nova Coronae of 1866 was twice as far away; that last was probably nearer to us than other Novae. Nova Pictoris is too remote for its distance to be ascertained by direct measures of its annual parallax. Attempts have been made to find its distance by the spectroscopic method, but the applicability of that method to Novae is rather questionable, and in fact very discordant results were obtained. Thus Mr. Davidovich found a distance of 540 light-years, while Professor Hartmann gave a value nine times as great. I regard the smaller distance as more probable; it would make the real light at maximum comparable with that of other Novae, while Hartmann's value makes it very much brighter.

The determination of the proper motion is of importance, in view of the star becoming double. Fortunately photographs were obtained twenty-four years ago with the Bruce lens of 24 inches aperture, which was then at the Harvard Observatory Station at Arequipa, and is now at the Boyden Station, Bloemfontein. The recent plates were taken before the detection of the star's duplicity, and no mention is made of duplicity on the old plates; but it must be remembered that the images of stars on photographic plates are generally several seconds in diameter, so that the images of two adjacent stars would probably be blended into one. The motion which Miss C. D. Boyd has derived from these plates is 0.042″ per annum towards the west, and 0.018″ towards the south, giving a total motion of 0.046″ in position angle 247°. It will be remembered that the zero of position angle is towards the north, and it is reckoned in the opposite direction to that of a clock face; that is, east is 90°, south 180°, west 270°. The Johannesburg telegram of 28th March gave the position angle of the line joining the two components as 70°, which is in almost the same line as that of the proper motion; a matter of some importance when we try to explain the duplicity.

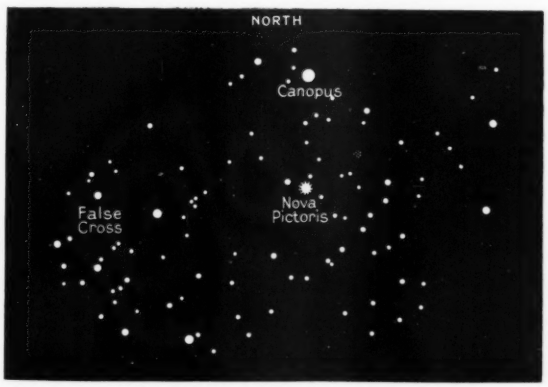
Dr. J. Lunt of the Cape Observatory made a most careful study of the spectrum of the Nova, and the changes in it during the first year after the outburst; this is described in the Monthly Notices of the R.A.S. for May, 1926. He notes that for a time astronomers had been unwilling to accept the interpretation of the very great shifts of the spectral lines in Novae as being due to rapid motion in the line of sight, but that they are now returning to this view. He quotes Professor Hartmann's sensational telegram to *Astronomische Nachrichten* with reference to Nova Pictoris, "Nova problem solved; the star swells up and bursts." The idea here is that some unknown cause made the interior of the star much hotter than usual, causing rapid expansion. The outer layers would be pushed outwards, without themselves suffering any great increase of temperature. Thus there would be an increase of light through the greater size of the disc, but at first no great change in the spectrum; then followed what Dr. Lunt describes as an "explosive outburst"; he suggests that this may have arisen from the diminution of pressure in the star's intensely hot interior, owing to the removal of the superincumbent layers.

Dr. Lunt gave the rate of increase of the star's diameter as 330 kilometres per second; this would

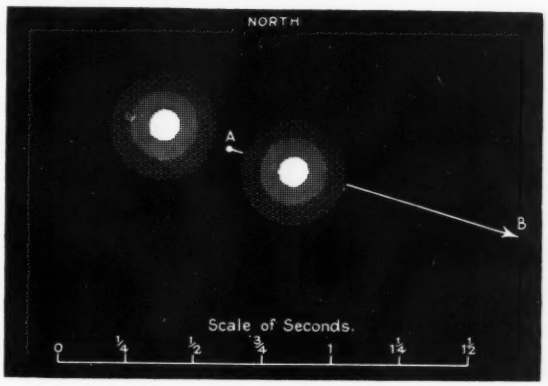
produce a disc equal in size to the orbit of Neptune after the lapse of five months; he anticipated that it would take somewhat longer than this for a visible nebulous disc to form. Such discs were seen in Nova Persei, in Nova Aquilae of 1918, and in another Nova in Ophiuchus in 1919. The nebulous ring round Nova Persei is not to be confounded with the much larger nebula photographed round the star in the autumn of 1901, which was rendered temporarily visible by the light of the great outburst of the star. That nebula may possibly have been the result of a former outburst of the star centuries earlier.

Actually a small nebulous ring was observed round Nova Pictoris last autumn; details are given in Harvard College Observatory *Bulletin* No. 856. Suspicions of such an envelope were aroused by photographs taken in October, 1926, at Arequipa. They could not be verified at that time, as the Observatory there was moved to Bloemfontein. Early in the present year the ring was photographed, being narrow, well defined, and of small density; it was proved not to be a photographic illusion by the fact that neighbouring stars of the same magnitude showed nothing of the kind. Professor Hartmann also photographed it at La Plata, and gave its diameter as one second.

The next development was the observation by the La Plata observers, about 26th March, 1928, that the appearance of the ring had altered. They at once telegraphed to the Union Observatory, Johannesburg, asking that it should be observed with the large refractor, of 26 inches aperture, which has lately been erected there. Mr. Wood and his assistants at once noticed that the star now appeared double; there were two rather ill-defined nebulous discs, of the same magnitude and appearance; each was about



NOVA PICTORIS AT ITS BRIGHTEST.
This shows the appearance in July, 1925, soon after its detection, when Nova Pictoris was a first magnitude star.



APPEARANCE OF NOVA PICTORIS ON 28TH MARCH.

Diagram, specially drawn for *Discovery*, showing appearance of Nova Pictoris as a double nebulous star, according to the Johannesburg telegram of 28th March, 1928. Distance of centres, half a second. Proper motion in twenty-four years 1.1 seconds, that is from A to B, which would be the motion of the centre of gravity. The line joining centres is in position angle 70°, the proper motion angle 247°.

0.40″ in diameter; their centres were about 0.50″ apart, and there was a narrow darker band separating them. On the other hand, Dr. Spencer Jones, His Majesty's Astronomer at the Cape, gave the distance between the stars as only 0.20″. The Johannesburg estimate of the distance is probably to be preferred, as their telescope is larger, and the observers there have had much practice in measuring difficult binary stars.

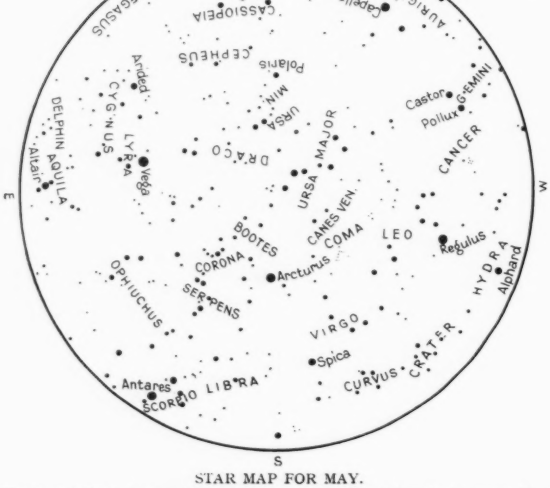
If the star really divided into two portions, the division must obviously have taken place some time before the duplicity was recognized. Taking the smaller estimate of the star's distance from us (540 light-years), half a second in angular distance means a real distance between the stars nearly three times as great as Neptune's distance from the sun. If they separated at the rate of a hundred miles a second the separation must have taken place about three years earlier, or about the time of the original outburst. The fact of their not being seen double earlier merely means that they were too close for our telescopes to separate them.

The theory that Novae arise from some kind of collision has been suggested by many people; some suggest collisions between star and star, others between star and nebula, others between star and planet. In the present case the fact that the two discs are closely similar to each other suggests that if any collision occurred it was between two similar bodies, that is, between star and star. This is the theory that Mr. Bickerton has vigorously upheld for over forty years; but most astronomers think that there are far too many Novae for this to be the general explanation of them. From the known sizes and distances of the stars, there would on the average

be only one collision in many million years, whereas we observe more than one Nova per annum when faint telescopic ones are included.

However, Nova Pictoris differed sufficiently from the average Nova to make it possible that it had a different origin from them, and in fact Dr. Spencer Jones, in a communication published in *The Times* of 29th March, appears to have viewed with favour the suggestion that there really had been a collision of star with star in the present case. If that was so, there is one point which differs notably from Mr. Bickerton's theory; he laid great stress on the fact that the portions of the two orbs that came into impact would coalesce to form a "third body" between the two stars, and that this body would for a considerable time be much the hottest and brightest body in the system. But the Johannesburg telegram of 28th March, if correctly interpreted, stated that the middle point between them had the appearance of a darker band, so that there seems to be no third body in the system. The outburst might perhaps be explained by two stars making a near approach to each other, each raising very high tides in the other. These tides might relieve the pressure in the interior of each star, and so indirectly produce the great increase of light.

An article in the *Observer* for 8th April suggested that the two colliding stars might both have been dark ones; this, however, is negatived by the fact that a star, of magnitude 13, was seen on photographs taken twenty-four years before; the same article suggested that the stars rebounded after collision, as though they were India-rubber balls. It seems to me utterly improbable that stars could behave in this manner.



STAR MAP FOR MAY.
The face of the sky as seen from London at 14 h. sidereal time (not summer time), 6th May at 11 p.m.; 22nd May at 10 p.m.

Two stars, the mass of each of them being equal to that of the sun, would pass each other with a speed exceeding 600 miles per second; but this speed would quickly diminish as they receded, owing to their mutual attraction; it is impossible to make an exact calculation without knowing the original speed of each star, as distinguished from that produced by their attraction. Supposing that a separation of half a second has occurred in two and three-quarter years, that gives an average separation of ninety miles per second, if the distance is 540 light-years.

The Future.

This is a reasonable amount; that in the first year would have been more rapid, and the present rate would have fallen to perhaps one-third of the above average rate; still, the outward motion ought to be manifest in the course of the next few months or years, and speculation is a little idle until we have more facts about the relative motion. It may be pointed out that if the present duplicity is due to a single star having split into two portions, their future career will depend on whether the rate of separation was greater or less than the parabolic velocity. In the former case they will recede from each other indefinitely; in the latter case recession will sooner or later be turned into approach, and the stars will meet each other again; but as they will probably have then expanded into large nebulous bodies, the meeting will be under conditions very different from those at the time of separation.

I conclude with the remark that while astronomers are pleased at seeing such a large amount of popular interest in this occurrence, they would be still more glad if the interest were a permanent one. There are countless marvels continually present in the heavens, but these attract little public interest; whereas anything of a bizarre nature, even when relating, as here, to a pair of faint telescopic orbs far out of reach of European observers, produces flaring headlines in our newspaper placards, and occupies many columns of text in the papers.

POSTSCRIPT:—A further telegram from Johannesburg reached Copenhagen on 14th April. It announced that a ring three minutes of arc in diameter now surrounds the Nova, and that two inner rings have also been photographed. These rings are too large to have been projected from the Nova at the time of the outburst. Presumably they were there before, and are now rendered visible by the light of the outburst reaching them.

The Birth of a Bird.

By F. B. Kirkman, B.A.

Everyone delights in Spring at the nesting birds, but how many of us believe that the chick breaks the egg with its beak? Chickens and pigeons have long been studied, but observation is wanted on wild species.

MUCH has been written about the development of the bird inside the egg, its embryonic life, but of its manner of exit from the egg relatively little is known, and this little chiefly concerns the domestic hen and the domestic pigeon. For the most complete account of the birth of the former we have still to go back to Réaumur's "Oiseaux Domestiques" (Mémoire VI), of which the first edition was published as long ago as 1749. An abstract in English of his results is to be found in a little book published in 1833, the "Domestic Habits of Birds," by J. Rennie. Réaumur's observations have been supplemented in recent times by Mr. F. S. Breed.* If to these be added Mr. W. A. Craig's† notes on the pigeon (*T. risorius*), we appear to have exhausted the literature of the subject as far as domestic species are concerned. Of the hatching of wild species there is no detailed account, although W. H. Hudson has left us in his "Naturalist in La Plata" a short but interesting note on the subject, to which we shall return.

What follows relates exclusively to the chick of a wild species I have studied for several years, the blackheaded gull (*Larus ridibundus L.*), the commonest of British sea-birds. It is the little red-legged, red-beaked bird that has in recent times made itself so familiar as a winter visitor to the parks and quays of London and other riverside towns. In summer it goes to breeding places, usually far inland, by the margin of lake, or loch, tarn or bog, and in some of these places it may be found congregated in thousands.

Cracks in the Shell.

Like the domestic fowl, the blackhead makes its nest upon the ground (Fig. 1), but is content usually with three eggs. Its chick, again, resembles the domestic chick in being covered with soft thick down, but differs from it in its colouration, which is usually some shade of buff or brown, more or less thickly spotted with black (Fig. 2). To a large extent, it resembles it also in its performance of the complex series of acts to which we now turn.

If towards the end of the third week of incubation, the eggs in a blackhead's nest be examined, there will be found on the surface of one of them an area of light cracks. This area extends until it occupies about a quarter of the circumference of the shell at its bigger end. If the egg is put to the ear, a rhythmic tapping is clearly audible. The rhythm varies from single taps to double, and some are stronger than others, but the impression left on the mind is that the process is automatic, like pulsation. One hears also a repeated cheeping, which makes it evident that the chick has already penetrated the inner shell membrane dividing it from the air-chamber provided by nature at the bigger end of the egg, and that it has begun direct lung breathing. After thirty or forty hours or so, the persistent tapping on the inner surface results in a small, clean cut hole being drilled somewhere in the cracked area (Fig. 2). I have records of it in the centre, on the right-hand, on the left-hand, and toward the top. Through this hole the tip of a moving beak is visible.

An Opening Lid.

After a few hours more, either a second hole is made, about half an inch to one or other side of the first, or else the latter is greatly enlarged (Fig. 3). If two holes, these are joined after a time by a simple fissure or split in the shell. Whichever form the breach takes, it extends roughly the width of the cracked area. That suffices. The tapping ceases, and is succeeded by periodic thrusting movements made with the whole of the chick's body. Their effect is to extend the split or hole both ways round the big end, and at the same time to force this end back, so that it becomes an opening lid depending upon a gradually narrowing hinge. A final thrust and the chick is free.

There we have in outline the process of hatching viewed from outside. The details of its mechanism have now to be described, and these differ with the two main phases into which the process divides itself.

The first phase is the making of a breach in the shell by tapping. It is well known that the instrument used for this purpose by all birds, and also by reptiles, including the crocodile, is the so-called egg-tooth. In birds it is a small, upward, peak-shaped projection on the tip of the upper mandible of the beak. It

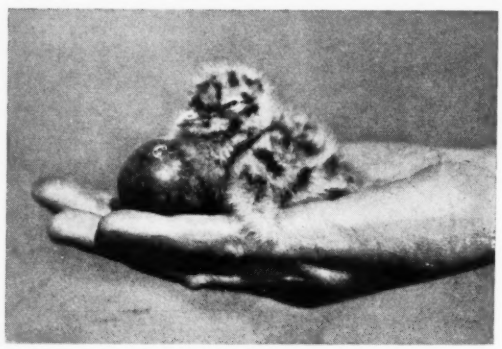
* "Instincts and Habits of Chicks." 1911-12. In the *Behavior Monographs* published by Holt.

† *Journal of Animal Behavior*, II, 1912, 296-8.

appears a few days before birth and, having performed its unique function, disappears gradually after the chick's exit from the egg. Its position on the top of the point of the beak implies that the taps are upward movements. I was not surprised, therefore, to see upward movements when I broke away the shell at the spot where the tapping occurred. The same fact has been noted by Mr. F. S. Breed, in the case of the domestic chick. It is a fact that disposes of the popular notion that a bird pecks a way out of the egg in the sense of striking forward with the end of the beak. Occasional pecking movements, have, it is true, been recorded. "At times," Mr. Breed writes of the domestic chick, "before the egg has been broken in two, one does see short, quick, forward thrusts of the bill, followed by working of the mandibles. And chicks, only a few hours out of the egg, may be observed repeatedly executing what might be called a pecking reaction 'into the air,' followed by a clapping together of the mandibles."

FIG. 1.
BLACKHEADED GULLS AT THEIR NEST.

In the case of the blackhead chick, I have heard occasional taps that had a sharper sound than the usual. These may have been made with the tip of the beak, and were possibly the accidental result of the bird's movements as it shifted in the egg. Also, after the chick has effected its release, I have observed opening and closing movements of the beak, which may be the same as the "pecking reaction" described above. These movements are interesting and puzzling, but they have little or nothing to do with the perforation of the shell, which is obviously the function of the sharp-pointed egg-tooth.



[*Photographs by F.B.K.*

FIG. 2.
BLACKHEAD'S EGG AND CHICK.
The first hole drilled through the shell by the egg-tooth of the bird inside is here shown. The chick differs in colouration from the domestic fowl.

On breaking away the shell I found not only that the movements of the beak are upward, but also, as indeed the rhythmic tapping had led me to expect, that they are automatic; they seemed to me to be clearly part and parcel of the strong pulsation of the whole body, due presumably to the onset of lung breathing and blood circulation. Each tap is one with each throb of the body. Thus the perforation of the egg is an involuntary act; the chick is not trying to make a breach; on the contrary, its achievement results automatically from the pulsation of its body in the sense that this pulsation is the sole source of the motive power or energy that keeps the egg-tooth tapping on the inside surface of the shell. Whether this is true of the domestic chick, the pigeon, and of wild species generally, remains to be ascertained. If it is true, it provides a remarkable solution of the problem of exit, a solution involving the utilization of the throbs of the chick's body to drive a highly specialized tool, the egg-tooth, devised by nature *ad hoc*.

The first phase of the blackhead's exit ends when it has made a fissure in the shell extending about a fourth of the way round the larger end of the egg. Herein it differs from the barn chick and duckling, also from the pigeon as observed by Mr. Craig. All three extend the line of cracks nearly round the circumference, the direction, as noted by Réaumur in the case of barn chick, being from left to right: "il fait sur son propre corps une révolution de gauche à droite." It does this also in the rare cases when the fore end of its body is lodged in the small end of the egg. The blackhead appears to proceed in either direction; that is to say, I have found the second hole it perforates, either to right or left of the first (Fig. 3). The distance it moves is, of course, relatively small.

Réaumur asked himself whether the chick shifted round from left to right with the aid of its beak or its legs. He assumed it must be one or the other. As he could not devise any way of determining the part played by the legs, he turned his attention to the beak. He removed the shell along a portion of the line the beak was to travel; thus ensuring that it would strike air. If it struck air only, and

the chick still progressed to the right, then the inference would be that the beak played no part in its progress. Both the two chicks experimented with progressed beyond the prepared fracture, and proceeded with its extension. Réaumur concluded that the turning movement was effected by the legs. What remains to be known is the stimulus that impels the chick to effect the turning movement.

The second phase in hatching lies between the completion of the work of the egg-tooth and the final exit. During this phase the blackhead chick, as already stated, is making periodic thrusts, the effect of which is to push the big end or cap of the shell outward, and so open the way to release. What is the mechanism of these thrusts?

If one examines the chick in the shell, one finds that it is in a very curious position. It lies with its head and the fore part of its neck curved down under the body, its throat facing its stomach, and not only so, but the head is, as it were, bolted into place by the beak, which passes upward between the right arm (wing) and the side of the breast. This position I found, after making my investigation, corresponds exactly to Réaumur's description of that of the domestic chick: "Il est presque mis en boule; son col en se courbant descend du côté du ventre, vers le milieu duquel sa tête se trouve placée; le bec est passé sous une des ailes . . . ; cette aile est constamment l'aile droite . . . "

FIG. 3.
BLACKHEAD'S NEST WITH TWO EGGS.
This gull nests on the ground and usually lays three eggs. One of those illustrated above shows two holes made by egg-tooth. After a time these become joined by a split in the shell.

The effect of the blackhead chick's position is that its spine forms an arch supported at one end on the legs, and at the other on the back of the neck and head, as shown in the diagram which corresponds generally to those of Réaumur (Fig. 4). The thrusts appeared to me to be upward thrusts of the spine, and it is easy to understand that they are very powerful, seeing that they have behind them the double leverage of the muscles of the legs and of the back of the neck.

According to Réaumur the domestic chick thrusts the body forward, not upward, and it does so by means of the legs. This one would expect, for it has not, like the gull chick, to extend the fracture, but only to push out of the way a cap or lid already nearly detached from the body of the egg.

Here again, as in the case of the taps of the egg-tooth, there is reason to think that the achievement of release from the egg is not what moves the chick to action. Its movements at this stage seem to be directed solely to the more immediate object of freeing its head, the physical stimulus being no doubt supplied by the increasing squeeze of the head between the growing body on the one side, and the inside of the shell on the other. It is not a posture that any animal would be likely to tolerate indefinitely.

The first act in the process of release may be called that of unbolting; in this, the blackhead chick, after long efforts, manages to release its beak from between the wing and the flank. Here one may well demand what purpose this peculiar position of the beak serves. It probably adds force or backing to the upward tapping of the egg-tooth, for this, of itself, can hardly be very effective. Réaumur goes further and suggests that the blows are guided by the wing and body.

Once the beak is released, the withdrawal of the head from under the body is relatively simple. It is effected by a sudden and violent jerk, extremely difficult to follow; one moment the head and neck lie pressed between the chick's under-parts and the shell; next moment they are stretched out in front, and the exit from the egg is thereby practically completed. No such sudden or violent movement was observed by Réaumur of the domestic chick: "it draws its head from under the wing, stretches out its neck . . . "

The exit, as far as the blackhead is concerned, is not the end of the tale. Almost as soon as clear

of the egg, the chick continues periodically to repeat the thrusting movements, though their purpose has been realized. The movements are now more easily observed: both the powerful arching of the spine, which seems to some extent independent of the leverage of its supports; and also the upward push of the legs. A few of the thrusts end in the chick visibly moving *backward* an appreciable distance; these may represent part of what takes place in the egg when the head is released, with the difference that, the backward movement being met by the shell, there is no regression, but possibly a lift of the front of the body sufficient to permit the release. Occasionally I have seen the chick get its head again under the body, and again free it by an instantaneous jerk, still difficult to follow. These curious post-natal movements go on for some time. I have noted their occurrence not less than three-quarters of an hour after birth. They provide an interesting example of a reaction taking place, though its external stimulus has ceased to be operative, and continuing to do so, apparently in obedience to some law of periodicity.

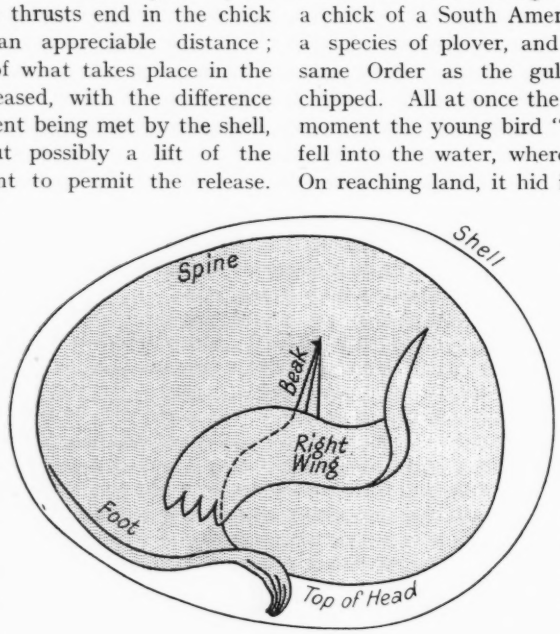


FIG. 4.
POSITION OF THE CHICK IN THE EGG.
This diagram represents the position before hatching. The spine forms an arch supported at one end on the legs, and at the other on the neck.

It remains to be added that the chick just out of the egg is a wet, miserable-looking little creature, cheeping as it lies, and far from attractive, except for the bright eyes, across which, at instants, there passes, like the shutter of a camera, the third eyelid or nictitating membrane, with which everyone who has to do with birds becomes familiar.

The whole process from the first light network of cracks to the final exit, takes about forty-eight hours, a figure that is a rough approximation only, for I was unable to get exact estimates. The period varies no doubt from chick to chick. According to Réaumur the time between the making of the first hole by the domestic chick and its exit varies from one to forty-eight hours! Some chicks, he says, work continuously, others intermittently. He ascribes this in part to variations in the thickness of the shell. I have myself found a partridge egg so thick that it was impenetrable; the chick lay dead inside. Another two or three hours more of wind and sunshine are needed to make the chick resemble the contented downy little bird shown in Fig. 2.

It would be of great interest to have records of the hatching of chicks of other wild species. That they will show considerable differences is likely. An indication of this is provided by the fact related by W. H. Hudson, to which allusion has already been made. He was holding in his hand an egg containing a chick of a South American jacana (*Parra jacana*), a species of plover, and therefore a member of the same Order as the gulls. The shell was already chipped. All at once the egg parted, and at the same moment the young bird "leaped" from his hand and fell into the water, where it at once began to swim. On reaching land, it hid itself in the grass. Here we get behaviour strikingly different from that of the domestic chick and the blackhead chick. Neither of them would be capable of such activity for some time after their release from the egg.

Hudson thought that the baby jacana's sudden exit was the effect of the anxious screaming of its parents. This is doubtful, judging from a somewhat similar incident recorded by Mr. R. T. Moore in the "Auk" (1912, p. 218). It relates to another species of plover, the least-sandpiper (*Pisobia minutilla*) found nesting by him on the Magdalen Isles, in the Gulf of St. Lawrence. The egg "broke open violently, as if by explosion, the two sections shooting to opposite sides of the nest." The chick celebrated its exit by a vigorous exercise of its wet arms (wings), one of which, striking the smaller section of the shell, sent it flying. Any further activity was suppressed by the parent bird, which proceeded once more to brood regardless of the figure bending over its nest.

We have here, as probably also in the case of the jacana baby, a seemingly normal hatch. What distinguishes both plover chicks from the chicks of the barn-fowl and the blackhead is their greater precocity; they are born with a much freer use of their limbs. What makes their manner of exit seem abnormal is its suddenness; but this suddenness becomes intelligible if regarded as an effect of the precocity. It is more than probable that the degree of precocity of the nestling at birth is the main factor determining specific differences in the hatching process.

Correspondence.

THE PROBLEM OF ABNORMAL AUDIBILITY.

To the Editor of DISCOVERY.

SIR,

The article in your April issue by Mr. Britton on audibility at a distance, and zones of silence, is most interesting. But I raise the question whether it answers to mathematical facts. The argument is, that because sound-velocity increases with the temperature of the air, and that temperature has been found to increase above seven miles (the minimum temperature height), therefore the direction of a sound will first bend upwards till it reaches the limit of seven miles, and then bend back more and more till it finally reaches earth again. Now this might happen if the sections of air were wedge-shaped as to produce a prismatic effect; but I do not see how it could happen if the air is stratified in strata of hot and cold. It is an elementary theorem that if a beam is refracted through a succession of media, the total change of direction will be the same as if it had passed direct from the first medium to the last. This shows at once that the total bending cannot exceed that produced by the beam of sound passing from air of earth-temperature to air of the highest temperature that we can imagine prevails at any height. But in any case the bending would still be upward, so that no amount or complication of refraction could possibly result in an earthward direction.

I suggest that it might be more to the point to inquire whether the beam of sound may be *reflected*. Energy cannot be lost. And if a beam of sound is a transference of energy along and in air, what happens to it when it reaches the confines of the air? It cannot simply cease. We might along these lines obtain the explanation of the return of sound, but not by refraction.

But there is another problem Mr. Britton does not refer to, and that is the dying away of sound at short distances. He passes over this as apparently "normal" inaudibility. But if this is "normal," *i.e.*, due to the necessary faintness owing to distance, how does his theory of refraction through an immense curve do anything towards explaining the "abnormal audibility" at much greater distances? Going up to heaven and coming down again in that sense will not effect any improvement in the direction of audibility. Thus his article neither explains the direction of the beam nor its effects.

I suggest that if it can be shown that the beam is returned by some method then the silent zone might be one of "interference."

Yours, etc.,

St. Nicholas Vicarage, Durham. WESTLEY BOTHAMLEY.

To the Editor of DISCOVERY.

SIR,

Mr. Britton's article on "Abnormal Audibility" brings to mind an incident I noted during the war which is not altogether unconnected with this question. It seems that under certain conditions, which I have not been able to determine, a solid body acts as a sounding board, and renders an inaudible sound perfectly audible within a certain radius of that body.

About the middle of 1916 I was stationed for a few weeks at Gravesend Barracks, and at one end of the parade ground there is a brick wall about seven feet high. I noticed one evening, that when standing quite close to the wall, the sound of gunfire in France was perfectly audible, but upon moving away from the wall not a sound could be heard. I cannot now remember the exact distance at which the sound became inaudible, but it is safe to state that it was a matter of about four feet at the most. The probable cause is that the much weakened sound waves upon striking the face of the wall were reflected off, possibly along their own path, and were thus strengthened up sufficiently to be heard within a very short distance of the wall; but both the incident wave and the reflected wave were far too weak to be heard without being somewhat enhanced.

Yours faithfully,

St. Mary's College, Middlesborough. JOHN L. A. SILLEM.

Mr. C. Britton writes:—

"In his comments on my article, Canon Bothamley assumes that the stratification of the atmosphere as regards temperature is necessarily in horizontal planes. This certainly need not be the case. I specifically pointed out that sufficient bending to secure the return of the sound ray would occur 'if circumstances were favourable.' If the stratification were slightly convex downwards at any point sufficient 'prismatic effect' would be obtained to produce the necessary amount of refraction. Any hypothesis based purely on reflection cannot explain the regions of silence. Interference cannot be invoked here as it only applies to the case of *continuous emission* of sound; the phenomenon cannot occur in the case of an isolated sound wave, such as an explosion."

APRIL HUNDREDTH ISSUE.

To the Editor of DISCOVERY.

SIR,

May I congratulate you on the success of *Discovery*. I hear on all sides of its wide appeal. I think that you have solved the problem of producing a magazine that is read in schools as well as by the general public.

Society of Public Analysts. C. A. MITCHELL.

Dr. C. S. Myers, F.R.S., Director of the National Institute of Industrial Psychology, writes:—

"I wish to congratulate you on the hundredth number of *Discovery*. I read it over the Easter holidays with the greatest pleasure and interest. To my mind the number is by far the best that has as yet appeared. I need hardly say how much I wish that the magazine may continue to increase in circulation and prosperity."

PAGAN FESTIVALS IN MODERN EUROPE.

To the Editor of DISCOVERY.

SIR,

Mr. Pryde-Hughes' letter in your March issue has suggested a possible means of supplying something of interest to him, and also of enabling me to recover two references which have eluded my memory for about twenty-five years. One is a work of Jankowski, bearing the title (if my recollection is correct) *Der Weihnachts Aufzug in Polen*; the other is by Sienkewicz, on the folk-lore of various animals and birds, including the bear, stork, raven, etc.

From the fact that my intermittent searches have been unsuccessful, it is possible that I have confused articles appearing in some publication with the title of books. In any case, I shall be very grateful for any information and particulars which may help to trace the articles mentioned.

Yours faithfully,

Banstead, Surrey. H. A. AUDEN.

People of the Great Plains—II.

By J. E. Pryde-Hughes, F.R.A.I.

Continuing from our March issue an account of post-war experiences in Hungary, the author here deals with conditions on the famous Puszta. Ancient customs of ethnographical interest are fast dying out.

EAST of the mighty bend in the Danube, the traveller descends on to the Great Plain of Hungary, the Alföld. At first through a richly cultivated territory, which becomes more sparsely populated and less cultivated, the way leads to the bare, wild moors of the Puszta. This is the home of the grey, wide-horned cattle, descended from the cattle brought in by Arpad's tribes over a thousand years ago, and of troops of untamed horses that sometimes number five hundred in a troop. Wild fowl, birds of prey—including eagles—flocks of sheep and wire-haired pigs, make up the other inhabitants of the Puszta. At one time wolves and such wild beasts made their homes there; they have now been wiped out, though recently during a hard winter small packs have come down from the hills. The moors are bleak and bare enough, and there are no houses or villages at all. There are a few mud-brick huts, or *Tanya*, but the plainsmen do not sleep in them; they wrap themselves in sheepskins and sleep under the stars.

TYPICAL HORSEMAN OF THE PUSZTA.

These men tend the vast herds of horses and cattle which are bred on the plains. It will be seen that the saddle has no girth, so that when the rider is thrown he is not dragged by his horse, which has a rope bridle.

One stands on the edge of this brown treeless monotone of parched pasturage, and speculates: life seems to end here. The lack of human sounds gives at first the impression of vast silence, but soon the ear attunes to other voices, to other and strange murmurings. Insects—and they are multitude in kind and number—give life to the thin grass; at a reedy, quaggy rain-pool frogs splash and reed fowl flutter, while cranes and storks stand on their stilts in the shallow waters, lazily catching breakfast. A parent stork rises heavily and flaps off to the nearest village, with a tasty bit for a youngster impatiently waiting at home on the top of some unused chimney. A faint whistle comes from nowhere; it is an unseen shepherd instructing his dog. In the blue above a lark spills "pearls of song" and stops—something dark brown floats leisurely overhead and hovers—then another and another, for there are hawks of various kinds; and far away the King of the Sky, an eagle, threatens the presentation of a scene from the inevitable "tragedy of the wild."

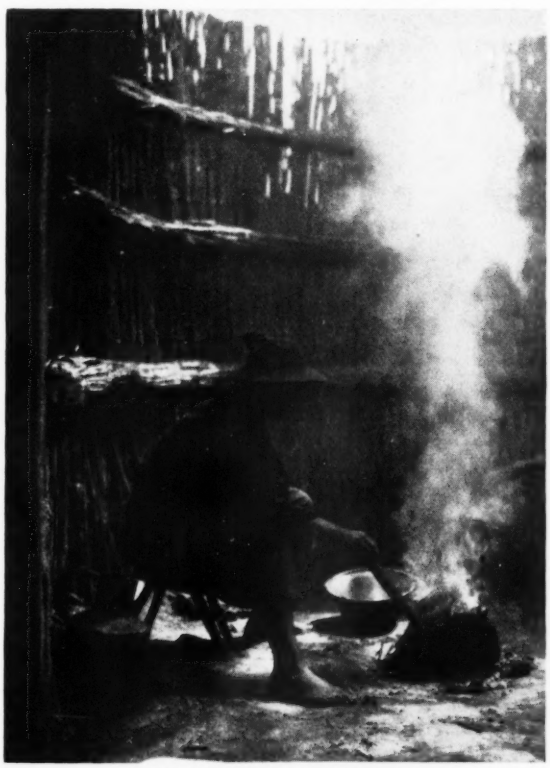
The plain is the home of the Csikosok, who tend the roaming troops of untamed horses, and year in and year out are rarely found seated on a stool or under cover. To live among them, the stranger should take a horse and everyone will greet him friendly. There is a secondary reason for a horse: the dogs of the shepherds and cowmen are shaggy, wild creatures, intolerant of strangers, and to go among them afoot and without ample protection is to invite an unpleasant fate. Fortunately the brutes cannot run very fast or far, as each has a rope collar with a piece of wood a foot long dangling from it, which taps the animal's knees and prevents his scurrying around and flurrying the flock.

As for the human inhabitants of the Puszta, they are splendid fellows—and handsome. I found a great pleasure in lingering to chat, and share with them their mid-day meal—a piece of fat bacon cured in *paprika*, a chunk of bread, and a large onion. It is

good—for the air and exercise on the plain make one hungry—and equally welcome is the *gulash*, or meat soup, which in various forms is always ready on the " hob," like the Welsh woman's tea.

I cannot say how many miles I covered over the Puszta, but the distances seemed interminable, with only the Delibab mirage that plays optical tricks on the horizon, and the mud huts at rare intervals to break up the space. As there is no timber on the plains—ignoring the few acacias planted round the huts for shelter—the fuel used is dried cow-dung, known as *belfa*, which may perhaps be translated as " belly-wood "—an allusion to its origin. This queer fuel is used for cooking purposes, not in the hut, but in a lean-to of rushes outside. Exactly speaking it is not a lean-to, but a survival of a primitive shelter, a relic of semi-nomad days when dwellings were not built for endurance but for the greatest temporary protection with the least amount of material and effort.

Tall rushes are bound together to make the walls, and the top is left open to the skies, the entrance being a mere " hole in the hedge." This is the original hearth of the ancient forebears of the plainsmen.



SHEPHERD PREPARING A MEAL.
The kitchen, a survival of a very primitive shelter, is made of tall rushes and adjoins the shepherd's hut (see upper photograph). The fuel used is dried cow-dung.

SHEPHERD'S SETTLEMENT ON THE PLAINS
The hut, on the right, is thatched with reeds and has no windows, while the " kitchen " adjoining is open to the skies. The men sleep in the open and use the hut for storage purposes.

At the widest end is an open fireplace, a depression in the ground; over this on a crooked bough is hung the deep pan in which all the cooking is done. A few stools around the fire—to-day these have replaced the horseskulls originally used as seats—a roasting spit, some spoons and ladles stuck in the rush walls, a flat barrel-like vessel for holding water, and the furnishing of the " kitchen " is complete.

The *Gulyas-Tanya* is the hut of the cowmen who tend the wide-horned Hungarian cattle, descendants of those beasts which the migrating Magyars drove before them, or harnessed to their wagons, from the steppes of Southern Russia. This windowless, reed-roofed hut is like all the others, except where cowmen and horsemen work together; then there is one room for the Csikosok (horsemen) and another for the Gulyasok (cattlemen). It is not a place to live in, but it is a storehouse for food and the different belongings of the men; the wonderful greatcoats, the " suba " and the " szur " hang on nails in the walls.

Every man on the plain has one of each. The " suba " is a long coat without sleeves, or rather it has amputated sleeves—mere stumps which are sewn up and decorated with braid, just as if the wearer were armless. The garment is thrown over the shoulders and held in place by a strap across the chest. The outside is tanned leather, generally hand-embroidered, with blues and reds predominating, though sometimes blacks, and also little bits of coloured leather. The wool of the sheepskin lines the inside, and in this garment the herdsman sleeps under the stars, wrapping himself up as in a sleeping bag on chilly nights. The " szur " is a much more elaborate affair, for festivals. Not so long ago the men embroidered and decorated their coats themselves

and made the simple articles and implements of their daily needs, but cheap and easily obtainable manufactures are unfortunately rendering this industry of the plainsmen unnecessary.

The " menes," or troops of horses, run wild on the plains with the Csikosok ever in attendance. It is wonderful to watch these fellows. Three of them generally handle a bunch of several hundred half-wild animals. On the move, one Csikos on each flank and one in the rear, they round up the horses into a troop and keep them going in the desired direction.

The water hole, however, is the great magnet which keeps the troop intact. As each troop is allotted a special section and well, the wanderers will always return ; however, when a storm arises, the horses get uneasy, and a thunderstorm is responsible for most arduous riding. The Csikosok then have to dash round like madmen throughout the storm, keeping the troop turning in a circle so that a whirlpool action holds it together. Sometimes this lasts for hours ; all the while the Csikosok must ride as for life, the great short-handled stock-whips cracking around the ears of the frightened animals, and the dust rising in clouds till only a swirling mass of life is dimly visible.

At night this task is fraught with grave danger. The Csikos has no saddle proper ; it is the mere suggestion of a saddle—a piece of shaped cloth stuffed till it is a quarter to half an inch thick, a *numnah*, with the stirrup leathers attached. This is slung over the horse's back without girth or surcingle. It is quite unattached, and much practice and skill is required to mount. But the Csikos learns the knack in his infancy, and holding the apology for a saddle tightly to the withers with the left hand, he slings his leg across like an acrobat. To me it was an impossible feat, yet I saw the value of the arrangement : on this pot-holed land, in the dark especially, the wild riders come down frequently, but saddle comes away too, so there is no fear of being dragged among the troop and kicked to pieces.

In a bad season this sort of thing may happen frequently, and as the rains do not drain off quickly,

ETHNOGRAPHICAL MAP OF OLD HUNGARY.

The localities mentioned in this and the previous article are not usually found in modern maps. The natural mountain boundaries that surround the great plains of Hungary are now broken up politically. The frontier imposed by the Trainon Treaty of 1920, here indicated by the finely dotted line, has reduced the pre-war area from 326,000 to 92,720 square kilometres.

A SHEPHERD AND HIS DOG.
The dogs are somewhat dangerous to strangers, who are advised to travel on horseback. The vast expanse of the Puszta is here well illustrated.

dangerous stretches of marshland form, and bogged horses create an additional task for the Csikos. Sick horses, too, need his care, for he is concerned with the health of the animals in his troop. If there is any sign of illness which he himself cannot check, the affected animal is isolated and taken right across the plain to the veterinary surgeon. Such an event gave me a new insight into the character of the Csikos. Out on the Hortobagy Puszta we had run across a troop rounded up at a well. I took a photograph, and with the aid of my friend Söreghy, the young Debreczin archaeologist, I got into conversation with the chief Csikos, a man of few words but simple, courteous manners. His mount was nearer ten years old than five; its headgear consisted of a plaited string bridle, with a steel bit on a single ring, held in place by a wooden peg each side against a small disc of leather—a primitive, yet satisfactory contrivance. Round the animal's neck was looped the lasso.

The friendliness of the fellow encouraged me to suggest a few tricks with the lasso, and this was no sooner understood than the Csikos was on the ground with the lasso uncoiled, and in as long as it takes to tell, he had cut out three horses, bringing them one by one out of the troop. I learned later it was not chance work cutting out the three horses, for they had that morning been marked down as ailing and were later trotted off to the village miles away. It is extraordinary that these men recognize horses individually. From a troop of five hundred they will cut out a particular animal single-handed, but always, I noticed, the Csikos dismounts to use his lasso, which he wields with precision. It is perhaps easier to throw when standing, but the Csikos sometimes gets badly skinned when dragged along on the end of the rope by a refractory animal.

This day, too, we were to see the Delibab. Söreghy had spoken so much about it the night before, that I had got it into my head that the phenomenon was a kind of will-o'-the-wisp. I was even innocent enough to call attention to a moving light in the inky darkness, which, however, turned out to be a shepherd, or someone, wandering round with a lantern.

As the sun gathered power, Söreghy promised me the probability of Delibab manifestations about noon. I held my tongue, fearing there was some "leg-pulling" in process, but wondered how earth-gas was to be seen dancing around in broad daylight; I should have continued to wonder had not the term Fata Morgana been used and the mystery thereby dispelled. Before noon, however, when we were out in the centre of the Hortobagy Puszta, miles and miles from anywhere, the extraordinary mirage developed over the horizon. There appeared, as if standing on its head in a calm sea, a tiny church with trees surrounding it, and then again clumps of trees—always in this unruffled sea, and very clear-cut and distinct. The Puszta is a vast plain with scarcely any undulation, and nowhere a hill; the Hortobagy alone is something over a hundred miles in length from north to south. The soil is alkaline and is becoming more and more alkaline. When the lower layer of air gets hot—and it does so suddenly—one is treated to a characteristic of the desert, the mirage, or as the Hungarian plainsman calls it, the Delibab. Sometimes whole villages, which cannot be discovered even by telescope as they are below the horizon, float in the air, and groups of gigantic cattle and trees seem to sail in non-existing seas—all illusions, caused by the repeated refractions of light through the different air strata not being uniformly warmed.

CSIKOS AT WORK WITH A LASSO.
These Hungarian horsemen use the lasso in dealing with their herds—an art which they practised long before the American cowboy even existed.

Many fairy stories are woven round the Delibab: personified it is feminine, the daughter of the Puszta, wooed by the wind and the sun. Delibab loves the sun and flees before the wind; she shows her lovely face only when the sun shines and causes the mirage to appear to deter the wind which pursues her.

The geological foundations of the Puszta are the diluvial strata, and the few low ridges on the plain, which are scarcely to be detected, are accumulations of dust. The upper layer is of clay, and sand covers the clay. The soil is not suitable for agricultural purposes, and the pasturage is not in any way rich and luscious, except here and there round the pools and dead river swamps.

Bad Weather.

In dry weather the soil hardens like cement, but after heavy rains it becomes a sticky, treacherous mass, with pools of slimy water everywhere. This is a bad time for cattle and herders. Large tracks of ground are quite impassable, but it is worse still when hot sunshine follows rain; then it is positively dangerous to be abroad on the Puszta. The surface dries rapidly, yet underneath is a morass, so that there is a cement-like crust floating on a sea of mud. Animals sink through the crust, and can only be saved by the greatest exertions on the part of their guardians, while horse and man must step warily to avoid being bogged. As there is no firm ground on which one may get a purchase, extrication is a difficult task, and especially serious is the situation for the lonely rider, for he may shout for help all day without a soul coming anywhere within range of the loudest voice.

Before the regulation of the river Tisza the plain was studded with many more small lakes, ponds, and marshes, where wild fowl frequented in great swarms and found sanctuary. Some of these stretches of water still exist, and also the marshy ponds, but the Hortobagy river has ceased to flow. Spurned by its parent, with which it has now no connexion, this is but a long dribble of water, practically stagnant—an attenuated pond. Fishing has become a very tame affair as compared with the sport of former times when the flowing river was well stocked, and yielded good food to the plainsmen, who caught the fish with nets and by means of the ancient type rush-work traps. This quaint trap can still be seen, a maze into which the fish is drawn and from which it only escapes to make the acquaintance of the frying pan.

Though the atmosphere is dry, and except for exceptional spells comparatively little rain falls in summer, the climate is capricious—warm days are followed by exceedingly cold nights. It is frequently very windy, and then the dust is whipped up into sandstorms, which whirl steeple-high, stinging and cutting the face of the wayfarer so unlucky as to be caught away from cover, and nearly blinding the unwary.

I have mentioned that there are no elevations on the Puszta, but this is not quite correct. In certain parts there are a few scattered mounds, some from thirty to forty feet high and about 200 to 350 feet in diameter at the base. These are tombs, the work of man between the Neolithic age and the period known as that of the migration of the nations. When excavated in modern times nothing of account was found in them; a few odds and ends, mostly, I believe, of Avar origin, roughly dated the graves. Söreghy told me, however, with regret in his voice, that others had been before and had looted the resting-places of the early plain dwellers. The tombs have one value for the investigator: their presence proves that this waste, once abounding in game and fish, was inhabited by folk who probably pursued the chase, fished, and grazed cattle.

Monotonous hours and idle moments are many out on the plains, and the Csikosok and herders, denied all distractions, still whittle with their knives, cure skins, and weave myths. At meal times they sit round the big pan all armed with long-handled spoons which they dip into the gulash in turn, according to age and rank. Eating seriously, without talking, what do they think or dream? One rarely penetrates their mind—lonely and unread men have a natural suspicion of their thoughts. Perhaps they think of their work? Of the weather and the life around? I doubt it. I rather believe their minds turn back to the misty past, to the days of superstition and the birth of the myths and proverbs of the race.

The British Association.

It is announced that the King in Council has approved the grant of a Royal Charter to the British Association for the Advancement of Science. This new status as a body corporate will be of great value in enhancing the authority with which the Association brings to public notice many aspects of science; it will also be of legal advantage in regard to endowments, in particular for the custody of the home of Charles Darwin which was recently offered to the Association by Mr. George Buckston Browne. The many friends of the British Association will congratulate the officers on this Royal recognition, which follows closely upon the presidency of the Prince of Wales.

An Episode in the History of Geology.

By F. J. North, D.Sc., F.G.S.
Department of Geology, National Museum of Wales.

The recent discovery of a hitherto unnoticed paper by William Smith, the father of English geology, reveals his views upon some of the controversial matters at that time in dispute with Ecclesiastical tradition.

WILLIAM SMITH, son of an Oxfordshire farmer, and himself a civil engineer and land surveyor, is known, and rightly so, as the Father of English Geology. As a lad he showed an interest in stones and fossils, and as a man he used to advantage the opportunities, afforded during the course of his work in land-draining and canal-making, to study the peculiarities of the strata exposed at the earth's surface. He noticed that not only were the various layers of rock arranged in a regular order, one resting upon another, but also that the fossils of each layer were in some way peculiar to it; they thus enabled the various strata to be identified, when, owing to a covering of soil, or of rock, they could not be seen as continuous exposures from one spot to another, or when, having been locally washed away, as during the formation of a valley, they occur in discontinuous outcrops.

FIG. 1.
WILLIAM SMITH, LL.D.
A portrait at the age of 69, by Fourau, reproduced in John Phillips' memoir of Smith published in 1844.

Making use of these principles, he showed that the strata of the earth's crust were arranged in accordance with definite laws, and in 1815 he published a geological map of England and Wales on the scale of five miles to the inch. In addition to being the first true geological map, apart from some small manuscript maps of his own preparing, this laid the foundation of modern geological research, and became the basis of all later geological maps of this country, and the standard of geological maps for the world.

Smith's known writings deal almost exclusively with the practical application, in mining, quarrying, and civil engineering, of the important principles he discovered and enunciated, and he was, especially in his younger days, "remarkably disinclined to indulge in himself, or even to tolerate in others, mere speculation in Geology." This we learn from his nephew and pupil, John Phillips, who was also an eminent geologist, but it is apparent from his own writings as well.

The time, however, was one during which there was much discussion concerning the history of the earth's development, and during which geology was viewed with great disfavour by the Church, as being supposedly antagonistic to Scriptural teachings. Since Smith was a man who travelled much and attended many meetings, such as those of the Board of Agriculture, at which he met people interested in the progress of the new science of geology, it was difficult to believe that he could have formed no opinions concerning the matters that were so much discussed by his contemporaries, although hitherto practically nothing was known of the workings of his mind in that direction. It was known that he was in sympathy with the more advanced thinkers of his time, and rejected fantastic views like those of John Woodward and his followers, who claimed that the Deluge was the principal event in the making of the earth in its present form.* He considered that the Deluge was merely an episode in the earth's history, and that only the superficial gravelly and

* These views were discussed in *Discovery*, Vol. VIII (1927), pp. 118-122.

pebbly deposits that occurred beneath the soil in many places could be regarded as of "diluvial" origin. The idea that glaciers had once existed in this country, and that the superficial deposits were in many cases the result of the scouring and transporting action of ice, had not then been entertained—an illustration of the comparatively recent birth of some of the ideas that are now regarded as fundamental principles of geology, without which its whole fabric would collapse.

When the British Association met in Oxford, in 1832, Smith published a "Synopsis of Geological Phenomena," in which, for the first time, he expressed his views concerning the place of the deluge in the scheme of geology, but even this document only serves to illustrate—as will be seen from the extracts in Fig. 2—the line of reasoning by which he came to the conclusion that a Deluge had actually occurred.

The New Discovery.

A short time ago it was the writer's good fortune to discover a copy of another broadsheet published by Smith in 1835. It has not been noticed by any of those who have written concerning Smith's life and writings, and as far as can be ascertained it is the only copy now in existence. It owes its preservation to the fact that it had been bound up with a copy of the "Geology of Yorkshire" written by Smith's nephew, John Phillips, and formerly in the possession of John Edward Lee, who, although best known for his work on the Roman remains at Caerleon, was born in Hull in 1808, and was, in his earlier days, a companion of Phillips and an admirer of Smith.

The broadsheet is entitled "Deductions from established facts in Geology," and in addition to its interest as appearing three years later than the "Synopsis," which has hitherto been regarded as Smith's latest separate publication, it deals with the very matters upon which he seems to have maintained silence until reaching the age of sixty-six. There is no record of the circumstances under which the sheet was published, but it appeared in the year following Smith's retirement from active work, when he settled in Scarborough with the intention of completing the various investigations in which he had been engaged, and its opening paragraph suggests that he felt constrained to publish the "Deductions" in answer to inquiries that had been addressed to him upon the subject of the earth's early history. From certain remarks in it, there are reasons for supposing that it was in some measure a criticism of the "Principles of Geology," which Charles Lyell had first published in 1830, and which had been favourably received by many scientific people.

The sheet is too large to be conveniently reproduced here, but its general character may be indicated by extracts. It commences :—

"As doubts may remain in the minds of many of the Principles of Geology, I shall endeavour to exhibit the principles, long familiar to my mind, in a clear view, opened by the organized Fossils, which are the medals of Creation, the antiquities of nature, and records of time.

"It is certain that by the use of these in Geology we are carried back into a region of supernatural events . . . and see that in the Stratifications there have been Consecutive Creations and Destructions under water, which may be thus arranged."

Then follows the title, "Deductions from established facts in Geology." Smith recognized, first, a period during which the primitive rocks were formed, and when the earth was void of living things, followed by a period when stratified rocks began to form. It was at this juncture, he supposed, that living beings first appeared, and then for a time similar conditions prevailed, namely, the growth and death of living things, and the entombment of their remains in the sediments that accumulated on the sea floor.

The idea of evolution—that the living things of one period had necessarily descended from those of preceding epochs—had not then been seriously considered, and being aware that the fossils of the various rock systems were dissimilar, Smith concluded that, after a time, there commenced a "New order of things, essentially different from any 'causes now in operation,' distinguished by general destruction."

"Supernatural Changes."

The first created animals were destroyed by "a supernatural mode of extinguishing life," and they were replaced by a second creation, which was also destroyed, and replaced by a third, and that in turn by a fourth :—

"and so on successively by numerous alternations of stratification, numerous repetitions of new creations and destructions by which new species, genera, and families appeared, and others became extinct. Such changes as these which pervade this System must *each* be considered *supernatural*."

This was followed by "the cessation of the forming process—*a great supernatural event*" and the "First occurrence of DRY LAND, but in what period of time or in what manner it became dry we know not, nor have any data." Next came "THE CREATION—that of land Animals, the inhabitants of air, and most of those that inhabit the water, and the great variety of plants that clothe the Earth," followed by "The great *supernatural* event or catastrophe of THE DELUGE known by loose water-worn stones." "The Deluge," wrote Smith, "effected (by the agency of water) a most extensive destruction, evinced by bones mixed with debris. By these bones it is ascertained that there were land animals prior to the Deluge."

After the Deluge came a "CHANGE OF CLIMATE—ascertained by bones in the diluvium of cold climates, which belong to animals of a hot climate, and by an entire Elephant

SYNOPSIS OF GEOLOGICAL PHENOMENA.

Sources of Evidence.	Deductions.	Results.
By the remains of land animals mixed up with water-worn stones,	We ascertain that the	Earth was dry and inhabited.
By the boulder-stones everywhere scattered over the earth's surface,	There has been water in action.	
By the fossil shells in those boulders, identified with those in the stratified rocks,	We ascertain the way of action.	THE DELUGE.
By the height to which the boulders and sea-shells have been raised,	We get the force of action and height of the water.	

ILLUSTRATIVE EFFECTS OF THE DELUGE.

By alum-shale, organized fossils, those of coal, and mountain limestone, and boulders from all the rocks northward, in abundance,	The effects of a great current from the north are obvious on the Yorkshire coast.	The first rush of water was by sea from the North.
By the same,	with the like effects	Down the vale of York, from N.
By the absence of alum-shale fossils in the vale of Pickering,	Filey clift was not surmounted, which gives the height of	First rush of water about 200 feet.

Fig. 2.
EXTRACTS FROM W. SMITH'S "SYNOPSIS OF GEOLOGICAL PHENOMENA," 1832.

preserved in the Ice of Siberia—how effected we know not—seemingly a consequence of the Deluge."

Finally we have the "present order of things with a partially colder climate," a period during which animals are "successively renewed and destroyed in the order of nature."

The table is summarized in two concluding paragraphs. Smith deduced six distinct "orders of things" with five principal "supernatural events," and numerous "supernatural destructions." In his scheme,

"The Creation is the last, or principal one, of many preceding creations during the Earth's formation under water," and "The Deluge is the last of a long series of supernatural destructions."

The broadsheet is interesting as a record of a great man's thoughts, but it is still more so when considered in the light of contemporary geological ideas, for it shows how difficult it has always been to interpret facts aright when they are approached with a mind already prejudiced. Smith did not like to be unorthodox, and for that reason subscribed to views that, paradoxical as it may seem, were shown to be untenable by his own works, when their full significance came to be realized.

To appreciate the situation we must go back to the middle of the seventeenth century—the time of James Ussher, Archbishop of Armagh. By studying the chronology of the Biblical record he came to the conclusion that Adam lived about 4,004 years before Christ, and since, at that time, it was popularly supposed that the formation of the earth was an affair of six literal days, there arose a belief that the world was something less than 6,000 years old. The adoption of this belief had a retarding effect upon the development of geological ideas for nearly two centuries; for any attempt to explain the accumulation and deformation of rocks in so short a period, had of necessity to introduce supernatural convulsions, or to assume that all rocks were formed in the course of a few days in the condition and in the situations in which they now occur. Nearly all the eminent thinkers of that period were influenced by this belief, which gave rise to the fantastic "Theories of the Earth," to which reference has already been made.

Bitter Disputes.

Not only did Ussher's estimate retard geology, but it gave rise to long and bitter disputes. From 1701 onwards, the date 4004 B.C. was printed in the Bibles issued from the Oxford Press—by whose authority there does not appear to be any record—and this act, perhaps that of an over-zealous editor or printer, greatly increased the harm done by a wrong conception of Ussher's work, for the date came to be regarded as part of the Inspired Word, and before

many years had passed the facts relating to its introduction had been forgotten. This is reflected in the well-known lines in which Cowper, with characteristic mildness, protested against the assertions of those who, from the study of the rocks, were coming to the conclusion that the events which had resulted in the formation of the earth's crust must have required an enormously longer period than 6,000 years. He wrote, in "The Task":—

> Some drill and bore
> The solid earth, and from the strata there
> Extract a register, by which we learn
> That He who made it and revealed its date
> To Moses, was mistaken in its age.

The truth, however, must always ultimately appear, and as soon as men began to distinguish between the certain and the probable, and realized that the events of the past had been recorded in the rocks, the true story of the earth began to emerge, but it was inevitable that the supporters of the story should soon come into conflict with those who preferred the older, more established views.

The New School.

One of the first of the new school was James Hutton, an Edinburgh man, trained as a physician, but by preference an agriculturist. He, observing the action of rain, of wind, and of streams, upon the rocks around him, came to the conclusion that rivers make the valleys in which they flow, and that in doing so they transport material to the sea, on the floor of which it is spread out. In other words, as the surface of one land mass is worn away, the materials of a new continent are accumulating elsewhere. His views were first communicated to the Royal Society in 1785, and some years later appeared in an amplified form in his "Theory of the Earth, with proofs and illustrations."

Hutton taught the principle of uniformity in the operation of natural causes, and showed that the rocks of the earth's crust had been formed by the operation of the very processes that are at the present time engaged in modifying the earth's surface features. Thus arose a "Uniformitarian" school of thought in opposition to the Catastrophists, as the older opposing party came to be called, who saw in the hills and valleys, and the variously tilted rocks, the work of sudden convulsions, and of supernatural occurrences that accomplished the making of the earth in an incredibly short time. Such was the influence of "dogma" and "authority," however, that Hutton and his followers were bitterly reviled for making statements that we now regard as axioms!

If, as Hutton wrote, "The ruins of an older world are visible in the structure of our planet, and the strata which now compose our continents have once been beneath the sea and were formed from the waste of the pre-existing continents," the earth must be immensely older than 6,000 years—a period far too short for the destruction of so much rock and the accumulation of so much sediment. Indeed, he concluded that as far as visible nature is concerned, "we find no vestige of a beginning—no trace of an end," and the immediate result of the acceptance of Hutton's teaching was that geology came to be regarded as antagonistic to the Church, instead of, as was really the case, antagonistic only to certain dogmas which were based upon inadequate information and the attribution of unwarranted authority to Ussher's "date." The situation was rendered more piquant by the fact that many of the pioneers of geological research in this country—Michell and Sedgwick of Cambridge; Buckland, Professor at Oxford and Dean of Westminster; Conybeare, Dean of Llandaff—were prominent Church dignitaries. William Cockburn, Dean of York, was one of the leaders of those who protested against the new ideas, and almost piteously he asked Sedgwick:—

> "Are you convinced, after mature reflection, that you have discovered the truth? If you have satisfied your own mind, you may be able to satisfy mine, and thus to remove those doubts which make me at present fearing that you are leading many into error. . . . I persuade myself that you may not object to a friendly discussion on the subject. From my brother Dean (Buckland) I can hope for no such favour."

These words occur in the dedication of a book entitled, "A New System of Geology," which contained the substance of a paper read by the Dean at the 1844 meeting of the British Association at York. In it the Dean attempted to show that the whole of the present fabric of the earth's crust was formed and distributed in a few days, as a result of great volcanic outbursts upon the sea floor. The paper was not published in the Report of the British Association, but was subsequently privately printed, and copies are now extremely rare, but the arguments put forward by the Dean are so ingenious as to be worthy of special study.

A Prophetic Controversy.

The uniformitarian doctrine rested upon a foundation more solid than that of the school it was gradually replacing, and when Charles Lyell made it the basis of his "Principles of Geology," the dispute soon came to an end as far as those who kept acquainted with the advance of knowledge were concerned, although, in their enthusiasm, the uniformitarians were at first apt to claim more than

was justified by the information they possessed. This controversy, and the intensive research it provoked, laid the foundations of the modern view of continuity and evolution in the development of the earth and its surface features, and paved the way for the acceptance, a few decades later, of the idea of continuity and evolution in the realm of living things.

The reason for suggesting that Smith had Lyell's new work in mind when compiling his table of Deductions, is that he commenced with the remark that owing to doubts "in the minds of many on the Principles of Geology I shall endeavour to exhibit the principles long familiar to my mind," and, dealing with the periods of stratification, wrote of a "new order of things essentially different from any 'causes now in operation'—distinguished by general destruction."

The quotation marks enclosing 'causes now in operation' are in the original, and they are the only words so emphasized in the whole broadsheet. This would suggest that Smith was using what was, at that time, a familiar expression; and those are the very words which Lyell used in the alternative title to the first edition of his Principles:—

"Principles of Geology: Being an attempt to Explain the Former Changes of the Earth's Surface by References to Causes now in Operation." 1830.

The present title was not adopted until later editions appeared.

It is interesting to note that although in his earlier days Smith had no use for those who invoked "uncommon convulsions" to account for the earth's surface features, in his declining years he wrote of "a series of supernatural destructions," which not only gave rise to changes in the earth's conditions but, annihilating living things, had necessitated successive re-creations.

The explanation lies, no doubt, in the fact that in his retirement he was so intent upon developing his own views that he omitted to take into account the work of others. In the words of John Phillips, he "mixed too little with younger geologists to make the discovery that on the road which he opened were racers swifter than himself." He did not realize how great a part his own discoveries were to play in providing the means of solving the problems relating to the past history of the earth.

Little-known Orchids of Europe.

By T. A. Stephenson, D.Sc.

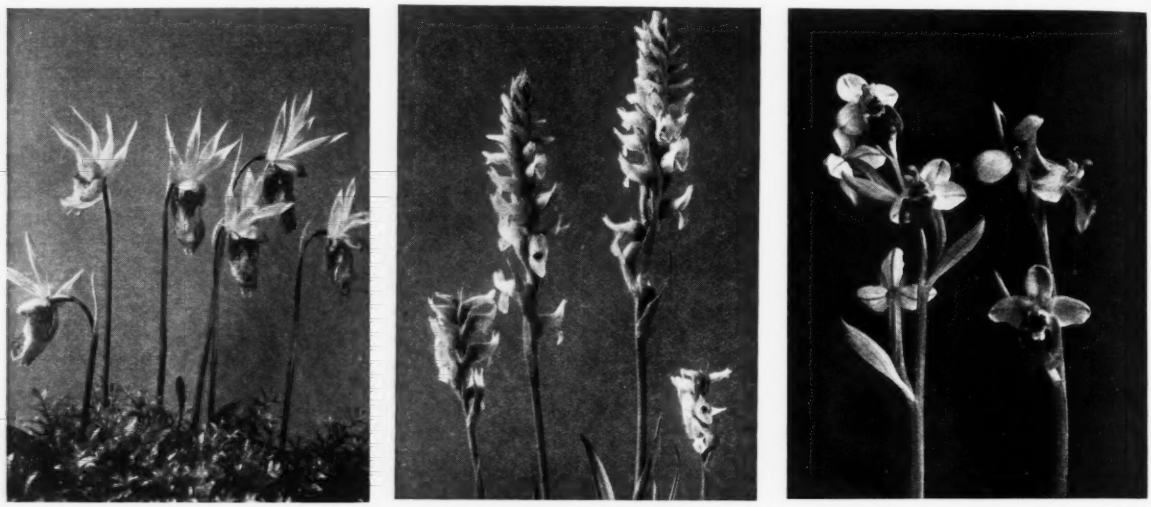
Department of Zoology, University College, London.

The wild orchids of Europe present a field for exploration which offers opportunities to the holiday-maker on the continent. There is much scope for the experimental hybridization of these curious plants.

TROPICAL orchids of the more showy kinds are familiar objects to many, with their curious and reptilian as well as elaborate and beautiful forms. Their culture, moreover, is a well-studied art, and a considerable amount of experimentally-gained knowledge exists of their potentialities and behaviour when hybridized with one another. The wild orchids of Europe, on the other hand, present a field which has been less fully explored, at least on the cultural and experimental side; nor are these plants well known to the public as are their tropical counterparts. The number of species of orchids which occur wild in Europe is, however, considerable, and although their flowers are usually built upon a smaller scale than those of the ordinary hot-house species, they exhibit a variety of curious form which parallels that of the larger and more imposing species. There exist, of course, many tropical species with small flowers; but since these are less often exhibited in public places than the showy varieties, their existence is not obvious to the uninitiated.

A few of the more interesting European orchids are illustrated in this article. Of these none is more beautiful than the species illustrated in Fig. 1, the rare *Calypso borealis*, in which each flowering stem bears a single pink flower with markings in other colours upon the hollow slipper-like lower petal (the *lip*). Another beautiful but extremely rare species is that shown in Fig. 2, *Spiranthes stricta*, more usually known as *S. Romanzoffiana*. This plant has small cream-coloured flowers, but they are borne in a graceful spiral formation upon the stalk. It is interesting particularly because of its distribution, being a plant which occurs in Ireland alone on the European side of the Atlantic, but which is not uncommon in North America.

It is a marked characteristic of the European orchids that many of them hybridize more or less freely in the wild, and that the hybridization is by no means limited to an interchange between related species; hybrids between species belonging to different genera



FIGS. 1-3.

INTERESTING TYPES OF EUROPEAN ORCHID.

(left). *Calypso borealis*, one of the most interesting of European orchids. 2 (centre). *Spiranthes Romanzoffiana*, the Irish 'Ladies Tresses." 3 (right). *Ophrys tenthredinifera*, one of the insect-like species.

are of frequent occurrence, and there are also on record cases which are probably due to secondary crosses between a hybrid and one of its parents or between a hybrid and another species. Some of the hybrids produced are plants of unusual appearance, and the manner in which the various characteristics of the diverse parents are combined in them also makes an interesting study. Most of our knowledge of these hybrids, however, has been gained by field work and descriptive analysis, and there is much room for experimental hybridization and for the following of the development of the hybrids through several generations. It has been claimed that among these orchids, as elsewhere, a new species may arise from the stabilization of a stock of hybrid origin, and an experimental proof of this would be a valuable contribution to the study of evolution. The difficulties in the way are, among others, that these terrestrial orchids cannot, any more than the kinds more usually cultivated, be successfully reared without an adequate nursery and much expenditure of time, and that a young plant produced from seed does not flower for a number of years—sometimes as many as sixteen —after germination.

The occurrence and peculiarities of hybrids may now be further considered. Wherever two species of orchid grow together, hybrids may occur (unless the species concerned should be such as to render hybridization impossible), but it does not follow that they will do so: in one locality hybrids between two given species will be more or less frequent, in another spot the same two species may grow together but no hybrids will be found. All species do not, moreover, hybridize with equal readiness. The hybrids produced are generally of the kind which present an appearance intermediate between that of the two parents, but sometimes (and especially in complex hybrids) the characteristics of one parent predominate; new features not apparent in either parent may also appear. In hybrids between the genera *Orchis* and *Serapias*, the flowers have no spur on the lip; in this case the spur is present in *Orchis* and absent in *Serapias*, and has been suppressed in the hybrids. In crosses between *Orchis* and the spurless genus *Aceras*, on the other hand, the spur is present, but is shorter than in *Orchis*. In some cases there is considerable variation between different examples of the same hybrid. A more detailed account of the hybrids of European orchids, which also takes into account the experimentally produced exotic hybrids, will be found in an interesting paper by Col. M. J. Godfery, entitled "Natural Orchid Hybrids," in *Genetica*, IX, 1927, p. 19. This paper is well illustrated.

Among the interesting facts which the artificial crossing of orchids has elicited are the following (quoted from the article by Godfery above mentioned). In some crosses the influence of the male or female parent is so strong that the other is swamped almost or quite completely. If *Sophronitis grandiflora* be crossed with *Epidendrum radicans*, the hybrid (which can only be obtained with the *Epidendrum* as male parent) is almost exactly like a dwarf *Epidendrum*.

An even more striking case is that in which *Zygopetalum Mackayi* was used as female parent in a cross with pollen from *Odontoglossum, Lycaste*, etc. The hybrids appeared to be pure *Zygopetalum*, and four hundred seedlings raised exactly resembled the mother plant. A plant of the fourth generation of *Zygopetalum*, fertilized in each case with *Odontoglossum crispum*, still reproduced the *Zygopetalum* unchanged.

A number of European orchids (belonging to the genus *Ophrys*) have the lip so modified that it resembles some insect very strongly, the other petals also lending themselves to the general effect. The sepals, on the other hand, remain petal-like, and are often brightly coloured, so that the total effect is that of an insect which has alighted upon a flower. The lip possesses smooth areas and hairy or velvety ones, and is so shaped and coloured that it may resemble either a bee, a fly, or a spider. That it is really intended to resemble an insect is evident from some of the details of its structure—it may possess spots resembling eyes, situated in the right place, and in one of the examples shown in the accompanying illustrations (Fig. 5), the lip possesses lobes which resemble folded wings (held out at an angle from the body) as well as hummocks at the bases of the latter which suggest the elbows of flexed furry legs. In other cases a bluish shiny area on the middle of the lip gives the illusion of the bluish sheen on the folded wings of a fly. There are too many resemblances involved for explanation on the ground of accident. The matter is clinched by recent observations, which show that in certain of these species the lip is mistaken by certain male insects for a female of the same kind; the male alights upon the supposed female and attempts to fertilize her; carrying away the pollen of the orchid incidentally, and with it effecting the fertilization of another orchid-flower. This adaptation is one of the most interesting instances of the type to be found; and it is one which calls for careful attention from those who would explain the phenomena of evolution by natural selection and by this alone.

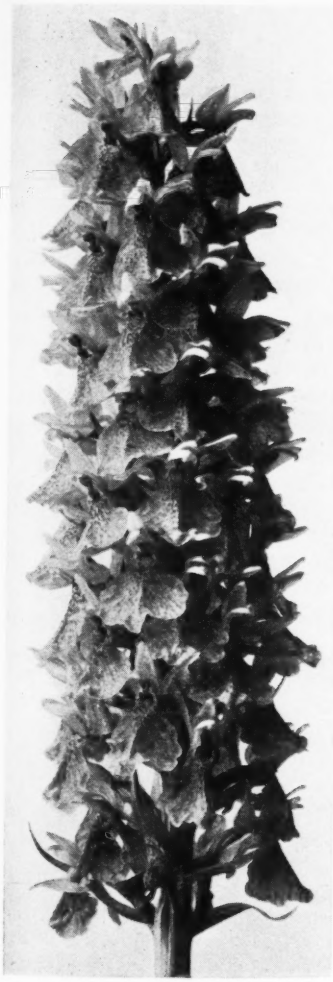


FIG. 4.
TYPICAL MARSH ORCHID.
(*Orchis Munbyana.*)

FIG. 5.
ANOTHER INSECT-LIKE ORCHID.
(*Ophrys Cornuta.*)

Many of the European orchids are relatively constant in type, the species being well marked and easily recognizable. This does not apply universally however, and the contrary condition is best exemplified among those species of the genus *Orchis* which possess palmately-divided root-tubers (the *Dactylorchids*). These are the marsh orchids and spotted orchids so common in Great Britain and in Europe generally. Among these forms the species are sometimes rather similar to one another, and in certain localities several of them occur together and hybridize so freely that a casual collector entering a field populated by one of these colonies might well be excused for mistaking the species and hybrids involved for a single kind of orchid exhibiting a wide range of variation. A considerable amount of work has recently been done on these difficult species, from which it has emerged that there are indeed a number of different kinds involved, with hybrids linking them up. The distribution of these forms is interesting. In North Africa there is found, to begin with, the showy purple species illustrated in Fig. 4 (*Orchis Munbyana*), a plant which may attain a height of three feet or more.

HOUSES OVER GRAVES IN NANOMEA, ELLICE ISLANDS.
(See descriptive paragraph on page 165. Photograph by courtesy of *Man.*,

In Spain, Corsica, and the southern part of France, this form is replaced by multitudes of a similar tall plant, with sword-like leaves and long purple spikes (*O. sesquepedalis*); this form is also found with *O. Munbyana* in North Africa. In the northern part of France, however, there appears a third species (*O. praetermissa*) which is rather like a shorter and more compact edition of *O. sesquepedalis*. This form extends into the Netherlands and all over the southern parts of the British Isles, but as one goes north and west in the latter area there become more and more frequent two forms (*O. purpurella* and *O. pulchella*) which resemble it but possess flowers of a rich deep purple unknown in the other kinds; one of these is distinctly a dwarf plant, and both of them are characteristic of the north and west of Scotland and of northern England. Other marsh or spotted orchids do not belong to the series just described, but range over the whole area involved, from the Shetlands to Spain or further; and in the eastern part of Europe other factors become involved. A detailed study of the marsh orchids, on modern lines, taking into consideration not only their morphology and cytology, but also their ecology, is being made by Dr. H. Ziegenspeck of the University of Königsberg; some of the results of this work, done in collaboration with the late Prof. A. Fuchs, have already been published in the "Botanisches Archiv" (II-XX), edited by Dr. Carl Mez of Königsberg, and in "Naturwiss. Vereins für Schwaben." Augsburg, 1919 and 1924.

It has been mentioned above that the hybrid *Sophronitis grandiflora X Epidendrum radicans* can only be obtained by using the *Sophronitis* as the female parent. Some of the reasons for results of this kind are as follows: The *Sophronitis* only develops short pollen-tubes; and the ripe seed-capsule of a *Cattleya* fertilized by its pollen produced mature seeds at the top only, the rest of the capsule being full of chaff. Similarly, *Cochlioda Noetzliana* is a good plant to use as female parent, but its pollen usually fails to fertilize *Odontoglossum*, whose pollen-tubes have a much longer distance to traverse. Again, in some cases the pollen-tubes of one species may be too large to enter the micropyle in the ovules of another. In yet other instances, the time which is required for the ovules of one parent to become ready for fertilization does not fit in with the time required for the pollen-tubes of the other parent to reach the ovules; the times involved varying from seven–ten days to as much as three months. If plants are crossed whose germ-cells require very different periods for these processes, the development of the ovules may be fatally checked by the failure of the pollen-tubes to reach them in time; as conversely the pollen-tubes may have lost their fertilizing power before the ovules are sufficiently mature to receive their contents. These facts are mentioned here, because although derived from the study of cultivated species, they are no doubt applicable to some of the wild forms also.

For the photographs which illustrate this article I am very much indebted to Mr. W. H. St. Quintin (Figs. 1, 2 and 4), Dr. F. Pfeiffer Wellheim (Fig. 5), and Dr. T. Stephenson (Fig. 3). Dr. Pfeiffer-Wellheim, of Vienna (Wien IV, Mommsengasse 21), has produced a series of beautiful stereoscopic photographs of European orchids, copies of which may be purchased from him.

Benn's Sixpenny Library: First Scientific Titles.

A Review by V. E. Pullin.

In place of noticing singly the volumes in the Sixpenny Library—a series now approaching its first anniversary, in which six new titles are published monthly—we shall review batches from time to time. This first review is by one of the authors, whose signature appears at the request of the Editor of DISCOVERY.

IN these days of intense specialization there is a very acute danger that education may be lost. It is an alarming thought, because if it comes to pass we shall find ourselves bankrupt of vision and isolated in the narrow paths of a labyrinth shut out from all beauty and even usefulness. The splendid Newtonian vision will no longer be the reward of the student of science who tends to become shut in by the narrow avenue of his speciality.

Messrs. Benn, like wise physicians, have apprehended the symptoms of this insidious disease and have prescribed exactly the right medicine; they have made it up, moreover, in the most palatable form. These little sixpenny books cover an incredibly wide field—science, philosophy, literature—indeed, the whole gamut of modern intellectual activity is comprehended in this little orange coloured library. Any attempt to review the series or any section of it must pay tribute to the Editor, Dr. William Rose, who so far has performed his arduous task in the most sympathetic and successful manner. Surely it has been no easy matter to persuade the eminent authorities whose names appear on these books to spare the time to write such careful accounts of their subjects. The achievement is most noteworthy.

Fact and Fancy.

Science has suffered in the past from a certain type of literature which is described as "popular science." Many such books may be popular, that is a matter upon which the respective publishers could speak; but often the science is entirely fanciful and partakes more of the character of, we were going to say, fiction, but perhaps musical comedy would be more apt in that there is not even a plot.

The scientific books in the Sixpenny Library, which form the subject of this article, are above all authentic expositions, and herein lies their value. The general reader may indulge his thirst for information in the perfect confidence that the knowledge he acquires, although of necessity sketchy, is nevertheless accurate. One of the striking impressions one gets after reading a number of these books is the enormous amount of information which the authors have managed to squeeze into their allotted eighty pages. In one or two instances it is positively amazing. It is striking testimony to the care which has been exercised in compiling the various accounts that in no case, in the scientific section of the library, is the book a mere catalogue of facts. Taken as a whole they are written in an interesting manner, while some indeed are almost masterpieces of literature.

One particular feature of the series which reflects credit on the Editor is the bibliography which is appended to each book. This is often divided into sections—elementary, more advanced, advanced, and so on—so that the reader may find the road into the very heart of the subject without difficulty. He should be warned, however, that he will not find many of the textbooks to which he is referred quite so appetizing as the carefully prepared sixpenny bait.

Why and Wherefore.

The man in the street nowadays lives almost entirely in an atmosphere of science, so that he is abnormal indeed if he does not seek to know something of the marvellous forces which he, consciously or unconsciously, invokes in every moment of his life. Sometimes when some striking phenomenon is made particularly conspicuous, as in the case of broadcasting, it constitutes a stimulus to delve into the outer mysteries of science, and thousands of people become active manipulators of valves and condensers because they can easily acquire sufficient proficiency to produce tangible results. Education, however, demands more than this somewhat superficial interest. It is the *why and wherefore* that constitutes the real interest and romance of science. How many people who buy and familiarly discuss the merits of wireless valves know anything of the stupendous little planets called electrons whose discovery made wireless valves possible?

The philosopher of Newton's time was thrilled by the realization of the order governing the movements of the heavenly bodies. In our time we have become aware of the extension of scientific order into planetary systems, millions of times smaller than the tiniest speck of dust that we can imagine. We have learned with an uncanny exactness all about the structure of that wonderful system, consisting of chiefly empty

space, which we call the atom. Still more wonderful is the knowledge that everything that we experience is made of discontinuous units. All matter is granular, and now it seems that not only matter, but light and electricity, far from being continuous wave phenomena are granular in structure also. Only a very few years ago it would have been a bold man who dared to say what electricity was. There is a story told of Lord Kelvin, who, when Professor Thomson, was lecturing to a class of students ; one of whom had fallen asleep. Thomson woke him up with the question, " What is electricity ? " The dazed student replied, " I am very sorry, Professor, I *did* know but for the moment I have forgotten." This story never failed to excite laughter --the one man in the world who knew what electricity was had unfortunately forgotten. If the same question were asked of any second year science student to-day he would have no hesitation in giving the correct answer at once.

Progressive Discoveries.

The romance of the progressive discoveries in physics constitutes a fascinating story that cannot fail to hold the most luke-warm inquirer. The Sixpenny Library tells the whole story. No longer is the introduction to science made laborious by a series of menacing symbols and equations which have no meaning until, by laborious spadework, the student has mastered the subject. That system has been replaced by the better one of first describing the wonder and beauty of a phenomenon. Then, having thoroughly whetted the student's appetite, it will be safe to leave it to his own interest to acquire knowledge of the more difficult and detailed aspects of the subject.

The Sixpenny Library lends itself very readily to systematized courses of reading, and in the scientific branch at all events a most thorough acquaintance may be formed with modern thought by arranging the titles in some simple order.

In the course of the following remarks on the first books* we shall consider them in the order that is suggested as being suitable to assist the reader to grasp current views on general scientific matters, and also at the same time to maintain a proper sequence of thought and interest.

Perhaps the first book to read should be *Sir Isaac Newton*, as it is a comprehensive sketch of the life and main scientific discoveries of the greatest scientist who has ever lived. He was born nearly three hundred years ago at a time when science was just emerging from the darkness of superstition. Newton's discoveries still form the very basis of modern scientific thought, and the story of the unfolding of nature's pages by this true superman will be found a useful foundation upon which to build our little course of instruction. Very naturally man's earliest interest in scientific or natural phenomena was concerned with the observation of the heavens, and it was in this field that Newton attained his most sublime triumph—the discovery of the Law of Gravity. Obviously then the next books on our list are those two charming essays by Professor George Forbes, *The Earth, the Sun and the Moon* and *The Stars*. There is no doubt that Professor Forbes teaches us how to acquire an astonishing amount of astronomical knowledge in the form of an exceedingly good game. Phenomenal distances are made intelligible. Such interesting things as the horizon, the mass of the earth, methods of measuring the distances of stars from us, the nature of the spots on the sun, the value of the spectroscope in telling us what elements exist on other planets, and a host of other fascinating matter is dealt with in a delightfully familiar way. In the book on the stars we are shown how we may identify any particular star with such homely apparatus as an open umbrella and a walking stick, and there are enough simple experiments described in the book to afford a season's entertainment far more thrilling and infinitely cheaper than anything that picture palaces or theatres could offer. A cursory acquaintance with the nature of the sun, earth and stars prompts us to search for more detailed information, and in Professor Arthur Holmes' book, *The Age of the Earth*, we shall find it. The earth is about 5,000 million years old. It is perhaps difficult to form any mental picture of such a stupendous time, but Professor Holmes arranges his evidence, and describes various natural time-keepers to such excellent purpose, that such matters as radio-activity and geological systems become almost as simple as clockwork and digging for worms.

The Infinitely Small.

In the last three books we have been considering vast systems involving the consideration of figures running into millions of millions. In recent years, however, science has rather tended to consider the infinitely small. We shall now have to train our minds to think of entities many millions of times smaller than anything we can see. Before doing so, however, it may be well to consider the general principles, as it were, upon which the scientist works. What are the laws which are always applied to any study of scientific phenomena ? Let us next take

* Published by Ernest Benn, Ltd., *6d.* each volume.

Dr. W. A. Caspari's book *The Structure and Properties of Matter*. Here we shall learn about the general laws of physics and chemistry without realizing that we are covering such a large field. Why is a lubricant a lubricant? Why is —273° centigrade the absolute zero of temperature? What is the difference between a body that is crystalline and one that is not? There are dozens of fundamental questions like this that we must understand if we are to gain any intelligent knowledge of modern science. Dr. Caspari answers them all with a clearness that denotes, not by any means the simplicity of the subject, but rather the carefulness and the skill of the master. The amount of information in this particular book is remarkable.

Modern Physics.

We will now proceed to Sir Oliver Lodge's *Modern Scientific Ideas*. To acclaim Sir Oliver Lodge as an expounder of modern science would be to gild the lily. In this book he tells us all about the discontinuous nature of matter, light and electricity, and the book forms an excellent preamble to the next one on our list, *The Atom*, which is the work of Professor E. N. da C. Andrade. This book in many ways is the most remarkable of the series. Professor Andrade has some advantage, perhaps, in that he writes on one of the most fascinating subjects of modern times, but this fact must not be allowed to take anything from the credit that is due to the essay. In the course of our study of the structure of the atom we have to learn about the nature of light and radiation in general. Professor Andrade explains how the atom broadcasts, as it were, the various forms of radiation with which we are familiar under the name of light, X-rays, wireless waves, and so on. He also tells us how the ability of atoms to combine and form chemical molecules is accounted for on the modern atomic theory. The facile pen of the author has endowed atoms and electrons with a strange familiarity and the reader cannot help feeling that here perhaps is the ground where applied science and speculative philosophy may one day meet.

In Professor Spielmann's *Chemistry* the importance of the subject is emphasized by the author, and we learn in what a variety of ways the science of chemistry is of importance to industrial activity.

This particular section of our scientific course of instruction cannot be closed to better purpose than by reading Professor James Rice on *Relativity*. This book deserves high praise. It is an attempt to perform a miracle, and it must be admitted that the attempt is, as far as it is humanly possible, successful. It is an excellent dissertation on Newtonian principles. The conception of relativity is dealt with in a most ingenious manner and without recourse to any mathematical symbols. There is no doubt that the reader obtains a clear idea as to the impossibility of absolute time and space. The emergence in his mind of a mental image of something to take its place is also unquestionable, but what that something is cannot be made clear without abstruse mathematical analysis. Professor Rice is experienced in the interpretation of this profound conception and, as we have said, comes as near to perfection as it is possible to do.

One excellent feature of this book makes it perfectly clear that Einstein has built his wonderful superstructure upon a Newtonian basis. There is a widespread belief that Einstein arose as an enemy and destroyer of all that Newton ever achieved. There is, of course, no greater error, and in *Relativity* the true perspective of the doctrine of relativity is set forth with admirable clearness. Particularly ingenious is Professor Rice's explanation of space-time. It is remarkable how he has succeeded in conveying a very real idea of this somewhat difficult concept without the use of a single mathematical symbol. The reader who carefully studies this book will certainly acquire a very cogent idea of the meaning of that singularly formidable word, relativity.

(To be continued.)

Houses in Graveyards.

A new ethnographical observation from Oceania is published in the April issue of *Man* by Mr. Patrick Buxton, who describes the erection of houses over graves in Nanomea, Ellice Islands. The body is buried in the ground, the area over the grave is strewn with white coral, and on this a house is erected. The larger house in the photograph which we reproduce on page 162 was the biggest seen, and was about five feet high to the ridge and six feet long. The native pastor explained that in old days burials had taken place in the houses of the village; but now that it has become the rule to bury in the cemetery, the people still erect a little house over the grave.

It is interesting to observe this blending of heathen and Christian customs in so intensely devout a place as the Ellice group. It appears that nothing quite like this is on record from any part of Polynesia, though Mariner describes the erection of huts in the burying ground of a chiefly family, and the strewing of the grave with white and black pebbles.

Book Reviews.

The Biology of Insects. By GEORGE H. CARPENTER, D.Sc. (Sidgwick & Jackson. 16*s*.).

This volume is one of a series of which, apparently, four others have appeared previously, and each deals with the biological aspect of some group of animals or plants. The book is really a number of essays in which the author has put together a large amount of material—and there is plenty of evidence of extensive reading—in a very pleasant manner. As a rule, the author has contented himself by telling his story without expressing definite opinions, but occasionally he comes out strong. For instance, he has a poor opinion of the theory of " race memory," and will not even allow that a student of insect behaviour would seriously suggest that an adult insect, in choosing its place for oviposition, could possibly do so by remembering its own larval life (pp. 102-107), a point upon which there is, at least, another opinion !

The author distinguishes between Family Life (Chap. VIII) and Social Life (Chap. IX), which is distinctly an improvement on Wheeler (" Social Life among the Insects "), but he then confuses the two, even after defining what he regards as the distinction. He says, " In some cases the members of a family remain in association for a shorter or a longer period of larval life ; when the association is preserved after the adult condition has been attained, the family may be said to pass into a community, and the life of such insects becomes definitely social " (p. 200). This definition is obviously incomplete, as it would include a swarm of locusts, which are certainly not social, and would exclude a similar association, a swarm of caterpillars (*e.g.*, " army-worms "), merely because the latter are not adult.

In the chapter on family life there are several pages upon secondary sexual characters and courtship, although family life usually begins after the courtship is over. In the early pages of Chapter VIII the habits of the Scolytid Beetles, known as " Ambrosia " Beetles, are dealt with as social, although the association of adults is only a family affair in so far as a male is polygamous, and is in no way comparable with the social life of Termites, Ants, etc. The real association is between mother and offspring, which should come under family life. In the last chapter, entitled " Insects and Man," the author sets out a few of the cases in which insects affect the human race, and only in a very few words does he refer to the question, recently raised by several authors, especially Forel, as to how far the insect societies are models of the human society. I would recommend the book as a sequel to the author's earlier volume entitled " Insect Transformation " for those who are seriously pursuing the study of entomology, but it is full of interest for those who are otherwise interested in the subject.

FRANK BALFOUR BROWNE.

Man Rises to Parnassus. By HENRY FAIRFIELD OSBORN. (Oxford University Press. 11*s*. 6*d*.).

In the introduction to " Babbitt," the non-American reader is warned that he may find Mr. Sinclair Lewis' style rather difficult. The same may also be said of that of Professor Osborn. Indeed, the book is composed in a style which will be strange and rather annoying to the average English reader, and by no stretch of imagination can the book be described as well-written. The use of the adjectives " geologic " and " archaeologic " appears strange and rather unpleasant to the Englishman, and yet, were the familiar " l " added to them, the style is far from satisfactory, and the book appears to be a series of comprehensive extracts from a number of authors, rather than a digested account from the author's mind.

There seems to be nothing new under the sun, for Professor Osborn shows us that the Greeks had definite ideas about the evolution of man, and quotes extensively from Aeschylus. The theme of the rest of the book is simply told. Briefly, it is an illustration of the author's particular views on the subject of human evolution. His ideas are too well known to need much mention here, but he derives modern man from a race of Tertiary " Dawn Men," who were not arboreal in their habits, and he inclines to the view that apes and men have come from entirely different stocks. Still, in his research into the Tertiary for relics of these Dawn Men, the author is content to stop at the Pliocene, and makes no mention of the flints of Puy Courny and Puy Boudieu of the Upper Miocene.

After a brief account of some selected Palaeolithic stations, we are introduced to the work of Oscar Montelius, who has applied the chronology of de Geer to the study of the dates of post-Palaeolithic cultures, and with this as groundwork, we review the " Mesolithic " and later periods. The illustrations to the book are exceptionally numerous and good, but it is certainly very strange to hear that the author made an excursion with " Professor J. E. Marr, the geologist of Oxford University " !

J. E. HALLIDAY.

The Elements of Economic Geology. By J. W. GREGORY, D.Sc., F.R.S. (Methuen. 10*s*.).

To the man in the street geology presents peculiar difficulties. Although desirous of learning the elements of the science, he seems to be up against a stone wall, and can find nothing tangible or perhaps even of interest to which he can firmly fix himself. Even enthusiastic geologists will admit that this is true, and the unbroken rows of specimens in our museums help but little to dispel this conviction. A perusal of this book will greatly help the understanding public to see and appreciate the economic aspect of geology, and will go far in helping to break down initial trouble and to lessen the fatigue caused by the " five finger exercises " of the science.

In *Discovery* for March we had the pleasure of reviewing the first book of this series, appearing under the general editorship of Professor J. W. Gregory. The general editor has now also assumed the role of author, and as we expected the high standard of the earlier work has been fully maintained in the present one. Incidentally the quality of the paper has been much improved.

To the more advanced pure or economic geologist it provides a wealth of information in the form of reliable text and numerous references, both from British and foreign sources. The increasing practice of dividing the index into a number of indices, comprising author, localities, and subject is, however, very annoying. The whole only comprises a total of fifteen pages, and we can see no valid reason for the division, except perhaps as a lesson in patience for those who have in the course of their daily work to consult some scores of indices. This agony was spared the reader in the first book, and we hopefully look forward to its elimination in the third and last of this excellent series—a book on general stratigraphy by Professor Gregory and Mr. B. H. Barrett, which we understand is now in course of preparation.

F. S. W.

Hermes : or the Future of Chemistry. By T. W. JONES. (Kegan Paul. 2*s*. 6*d*.).

This new volume in the well-known " To-day and To-morrow " series deals with the future of chemistry. Among the points dealt with by the author, as likely to be of great importance in the future, are the production of synthetic petrol ; changes in constructional materials, in the direction of new light alloys and new cement products ; the production of entirely new artificial fibres from cellulose (the author being of the opinion that in producing imitations of silk and wool we have not exploited the greatest possibilities) ; nitro-cellulose lacquers ; foods and the growth of crops ; and the development of a new chemo-therapy, in which it will be the aim of chemistry to enable the organism of its own accord to set its parts in order. Special emphasis is laid, in this last respect, on the remarkable results which may be expected to attend the increase of knowledge of hormones and vitamins.

Mr. Jones does not subscribe to the view that the food of the future will be a synthetic tabloid product, but is of the opinion that the direction of advance will be in the production of crops (wheat, etc.), containing various essential dietary constituents (carbohydrate, fat, protein, etc.) in the correct proportions. The production of meat will dwindle. On the chemo-therapeutic side, " the chemical control of sex cannot be regarded as remote, even though there appears to be no indication of its introduction in the immediate future. . . . The development in the child of a full complement of hormones will be an increasingly attended care of the future."

B. F.

The Fundamentals of Astronomy. By S. A. MITCHELL, Ph.D., LL.D., and C. G. ABBOT, M.S., D.Sc. (Chapman & Hall. 15*s*.).

This is a semi-popular treatise on astronomy, written by two well-known American astronomers. Some of the text and many of the illustrations have appeared in Dr. Abbot's previous book, " The Earth and the Stars," but this is quite by the way. The first chapter is entitled, " How to Know the Stars," and is in the nature of a flight of fancy, intended to stimulate the beginner to take an interest in the starry heavens. In Chapter II is given an interesting account of the most famous astronomers of the past and their labours. Delightful little biographical sketches are supplemented by a short, though interesting, account of the foundation and equipment of the Lick Observatory, and Mount Wilson Observatory. The next two chapters are devoted to the earth, its size, mass, internal condition, motions, etc. Chapter V contains a discussion on time, in its relation to astronomy. A good part of the chapter is concerned with the calendar and its history, and forms very interesting reading. The chapter closes with a brief sketch of the use of astronomy in navigation. Chapter VI deals with the moon and the tides. The photograph which is reproduced as Plate 13 is printed upside down, which was also the case with the same photograph in " The Earth and the Stars." Perhaps the publishers will note this and rectify it in the next edition. This slight error, however, does not detract from its value as an illustration. Chapter VII is a summary of what is known about the planets, and as it only occupies twenty-two pages, the treatment is necessarily somewhat sketchy. Chapter VIII is on " Comets and Meteors," in which there occurs, in addition to astronomical matters, a good story about Messier, the French discoverer of comets. The next two chapters deal with the sun and eclipse phenomena, and form a very readable account of solar physics. Chapter XI is one of the most interesting in the whole book, as in it the authors describe various ways of obtaining power on an industrial scale from the sun's rays. Needless to say, in our climate, very little can be done in that way, but in tropical countries sun-power engines have been tried with conspicuous success. The remainder of the book is devoted to stellar astronomy and astro-physical matters, the presentation being clear, accurate, and up to date. Perhaps the most thought-provoking chapter in the book is the final one, entitled " Building the Universe." The quality of the paper and the illustrations are excellent, though we are forced to the conclusion that the price seems a trifle high. However that may be, the book should appeal to a wide circle of readers who do not wish to struggle through a mass of technical stuff, but, on the other hand, want to know something about astronomy. A very readable book indeed.

J. A. LLOYD.

Ultra-Violet Rays in the Treatment and Cure of Disease. By PERCY HALL, M.R.C.S., L.R.C.P. (William Heinemann (Medical Books) Ltd. 12*s*. 6*d*.).

A Textbook of Actinotherapy. By D. D. ROSEWARNE, M.R.C.S., L.R.C.P. (Henry Kimpton. 9*s*.).

Physics in Medical Radiology. By SIDNEY RUSS, D.Sc., L. H. CLARK, Ph.D., and B. D. H. WATTERS, M.Sc. (Chapman & Hall Ltd. 12*s*. 6*d*.).

As the preface to one of these books points out, there is no need to emphasize the important part that radiology plays in medicine, whether in radio-diagnosis or in radio-therapy. The universities of Cambridge, Liverpool, and Edinburgh now grant a diploma in medical radiology, and their example is being followed by others no less anxious for the status of their speciality.

Professor Leonard Hill contributes an introduction to Dr. Percy Hall's book, in which he remarks that we cut off the natural effect of sunlight on the skin by clothes, glass, brick walls, and smoke pollution, while in winter the light in this climate is in any case very small. In a short time he predicts that arc light baths will be therefore widely used, and will have a great beneficial effect on city people in particular. As its title suggests, however, the book deals with specific diseases rather than with general conditions of health, which as everyone may benefit by sunlight and its substitutes are scarcely less important.

Perhaps Mr. Rosewarne's is the most comprehensive of these books. After dealing with the constitution of matter and physical phenomena, he proceeds to describe the types of instrument and the action of light on the body. In this last connexion he deals with the skin, the blood, and the effects of light on metabolism. A section of the book is devoted to clinical procedure, in which the forms of administration of light treatment are discussed with photographic illustrations. A chapter on limitations and dangers is wisely included, as considerable damage may result from the haphazard use of this new cure.

The third volume under review is written jointly by the professor of physics at the medical school of the Middlesex Hospital and two research assistants. This is a sufficient commendation for a work which everyone concerned with the subject should read ; it cannot be urged too strongly that a knowledge of the principles involved is of the utmost importance in ultra-violet treatment.

Animal Biology. By J. B. S. HALDANE and JULIAN HUXLEY. (Oxford University Press. 10*s*.).

The authors names are a sufficient commendation for this book, which is designed as an introduction to the general principles of the subject. They point out that recent brilliant work in pure physiology is now becoming linked up with general zoology, and we are in a fair way towards the possession of a real science of developmental physiology, linked up at one end with pure physiology and at the other with heredity. Evolutionary studies, after falling on somewhat evil days as the result of too much theorizing and arm-chair speculating, are feeling the stimulus of this new knowledge. In brief, biology is at last beginning to be a unitary science, in which discoveries in one branch rapidly come to alter our outlook in other branches.

The book has been written with these circumstances in mind, and unlike many of the available textbooks a detailed treatment of the subject is thus linked together by a continuous theme. The work is profusely illustrated, and while written simply is decidedly more solid than much of the "popular" scientific literature now being produced.

Rossel Island: An Ethnological Study. By W. E. ARMSTRONG, M.A. (Cambridge University Press. 18*s*.).

Rossel Island, the most easterly of the Louisiade group, Papua, occupies a position of peculiar isolation. Mr. Armstrong was for some months assistant anthropologist to the Papuan Government, and he also obtained grants from various learned societies to visit New Guinea and carry out ethnological studies among its peoples. This book was primarily intended as a general survey of the culture of the island; but the discovery of an unusual system of currency led the author to concentrate on an attempt to elucidate what turned out to be a very complex monetary system. He modestly complains that other aspects of the study have been rather summarily treated, but there are fully illustrated chapters on ghosts, religion, sacred places, and sorcery. The native games and songs are also described.

Aerial Photography. By CLARENCE WINCHESTER and F. L. WILLS, F.R.P.S. (Chapman & Hall Ltd. 25*s*.).

The admirable illustrations and production of this volume are in every way worthy of a pictorial science which has come to the fore in recent years. Not the least interesting literary feature is a foreword by Sir Alan Cobham, from which many will learn for the first time that this famous airman was himself connected with aerial photography in its pioneer days. He points out that although air survey developed rapidly during the war, there is still much room for improvement. There are two main branches of the subject, air survey and aerial photography: progress in the former was reviewed by Major Hemming in *Discovery* some months ago, while aerial photography is going ahead rapidly, finding new uses in commerce, especially for publicity purposes.

The "Wellcome" Photographic Exposure Calculator, Handbook and Diary, 1928. (Burroughs Wellcome & Co. 1*s*. 6*d*.).

We have received for review a copy of this popular annual, on which no effort has been spared to make the 1928 issue up to date and helpful. The scope and character of the book is reflected in its contents. The frontispiece shows a reproduction of an Alsatian wolfhound produced by a novel two-colour toning method which is described in a separate pamphlet just issued, entitled "Photographic Toners and Stains." Facing the title page of the handbook is an official photograph of the Duke and Duchess of York during their tour to New Zealand and Australia. The literary contents are written as simply as possible, and include articles on development by all methods, desensitizing, intensifying, reducing, printing, toning, etc. In the exposure section the plates, films, and papers have been carefully tested and the speeds revised, the list being made complete by the addition of all new material brought on the market up to the time of publication. An article on exposure in cinematography will be appreciated by the ever-growing number of motion-picture workers. It should be noted that four editions are issued, for the northern Hemisphere and Tropics; the southern Hemisphere and Tropics; Australia and the Tropics; and the United States of America respectively.

Qualitative Analysis. By W. WARDLAW, D.Sc., F.I.C., and F. W. PINKARD, M.Sc., A.I.C. (Longmans, Green & Co. Ltd. 3*s*. 6*d*.).

The authors offer this book as one which combines the good points of both types of work at present available on qualitative analysis, in that it is comprehensive and at the same time small in size. Many instructors in school chemistry prepare their own analysis tables for the use of their pupils, but while valuable in bringing out general principles, it must be admitted that such notes usually overlook details of importance. Hence the elementary student who pursues the subject to an advanced stage may find himself later on confronted with "snags" which throw out completely an otherwise simple analysis. This book is therefore welcome as supplying a complete elementary summary of the subject, combining extensive notes with clear tables.

Manual of Meteorology. Vol. II: "Comparative Meteorology." By SIR NAPIER SHAW, LL.D., Sc.D., F.R.S. (Cambridge University Press. 36*s*.).

The first volume in the "Manual of Meteorology," reviewed at length in these columns last July, dealt with meteorology in history. The second instalment is naturally more technical, and covers the general circulation of the atmosphere, its normal seasonal changes, and its transitory changes; there are valuable charts for the months of the year giving the mean temperature of the air at sea level. A useful feature is a summary of units of measurements, which faces Chapter I and is appropriately entitled "Lest we forget."

Universities Yearbook, 1928. Published for the Universities Bureau of the British Empire. (G. Bell & Sons Ltd. 7*s*. 6*d*.).

This well-known annual needs no introduction to educationalists, but it is equally valuable to editors and journalists who require particulars of those who hold academic appointments in British universities throughout the world. From the academic angle one of the most useful chapters deals with the admission into English and Irish universities of persons educated abroad. Another section is devoted to centres of research, and gives a list of recent theses accepted for the degree of doctor in the various universities. This affords a valuable reference for those who are contemplating such courses, and are anxious to know what subjects have already been covered.